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ORIGINAL ARTICLES.

I.—On some Bird Remains from the Upper Cretaceous of Transsylvania.[1]

By C. W. Andrews, D.Sc., F.R.S. (British Museum, Natural History).

So long ago as 1897 Baron Franz Nopcsa[2] recorded the discovery of numerous bones of Dinosaurs and Chelonians in freshwater deposits of Upper Cretaceous age at Szentpeterfalva in Transsylvania. Since that time he has made extensive collections of bones from the same locality and has published various papers concerning them. In his last collection, now in the British Museum (Natural History), there occur some fragments of limb-bones which he does not consider to be reptilian but rather of avian origin. These specimens he has kindly submitted to me for determination and description, and they form the subject of the present paper.

The limb-bones of which portions have been obtained are the femur and tibio-tarsus. The femur is represented by two imperfect specimens: of these, one consists of the upper end and about the proximal fourth of the shaft (Fig. 1), almost uncrushed and altogether in a very good state of preservation; the other includes the upper end and the greater part of the shaft, but in this case the bone has been much crushed and broken and the head and other prominences considerably abraded.

The head of the femur (*h.*) is large and would be nearly hemispherical if it were not for the large circular fossa for the attachment of the *ligamentum teres* (*l.t.*), situated rather towards the posterior side of the head and looking inwards and backwards. Ventrally the head is marked off by a well-defined groove, but above its surface passes into that of the great trochanter (*tr.*), the two being separated by a slight concavity only. The head as a whole is directed slightly upwards, rising a little above the trochanteric surface. This latter is gently convex and roughly triangular in outline, its most prominent angle projecting strongly forwards and inwards. The posterior angle is less prominent and is truncated by a deep muscle impression (*o.m.*), probably for the attachment of the obturator muscles. Beneath the trochanteric surface the anterior face of the bone is concave, the concavity being bounded above by the rather prominent anterior edge of the trochanter, and externally by a strongly developed forwardly directed ridge running down from the antero-external angle. The lower end of this ridge is continued

[1] Published by permission of the Trustees of the British Museum.

[2] Verhandl. d. k. k. geol. Reichsanstalt (Vienna, 1897), p. 273.

on to the anterior face of the shaft as a strongly marked *linea aspera*, which runs downwards and obliquely across towards the inner distal condyle; its full extent cannot be seen on account of the incompleteness of the distal end of the specimen. This ridge probably marks the line of insertion of the femoro-tibial muscles. The outer face of the trochanter is concave, owing to the presence of deep pits for the insertion of muscles, probably the *gluteus medius* and the *gluteus externus*. The surface truncating the posterior angle of the trochanter and probably serving for the attachment of the obturator muscles has already been referred to.

Beneath the trochanteric region the bone narrows to a shaft which is oval in section, the transverse diameter being a little the greater. The muscular ridge on the anterior face has already been referred to, and there is another strong *linea aspera* (*l.a.*) on the hinder face, beginning just beneath the trochanter and running downwards and outwards, apparently towards the outer condyle, and becoming very strongly marked at its lower end. There is some evidence that towards its lower end the shaft curved considerably backwards.

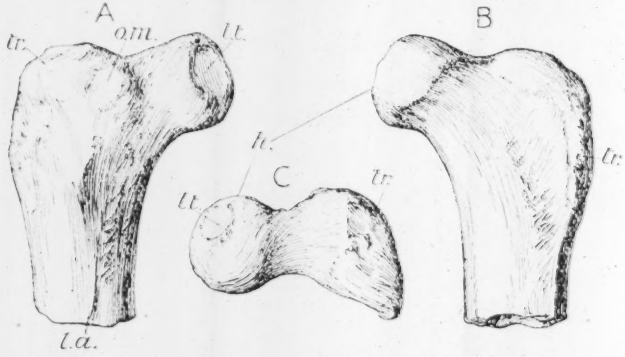


FIG. 1. Upper end of left femur of *Elopteryx nopcsai*, gen. et sp. nov. A, from behind; B, from the front; C, from above. Type-specimen, $\frac{3}{4}$ nat. size. *h.* head of femur; *l.a. linea aspera*; *l.t.* pit for the insertion of the *ligamentum teres*; *o.m.* point of insertion of the obturator muscles; *tr.* trochanter.

In the uncrushed specimen the fractured end shows that the wall of the shaft consists of a hard compact outer layer measuring from 3·5 mm. in thickness at the front and back to about 6·5 mm. at the sides. Within this there is a spongy layer of indefinite thickness enclosing a central cavity. Judging so far as is possible from the crushed specimen, the central cavity is larger towards the lower end of the shaft, the spongy layer being less developed, while the outer hard layer also is thinner. The outer surface of the bone is sculptured in a remarkable way, being raised into a series of fine wrinkles which are for the most part irregular and run into one another, though in some places, as for instance on parts of the anterior face of the trochanter, they may be more or less parallel, and in that case, as a rule, they run more or less in the direction of the long axis of the

bone. A similar sculpture may be seen on some bird-bones, e.g. on the femur of *Phalacrocorax* and to a less extent in *Pelecanus*, but in these cases it is less distinctly seen, being partly masked by the presence of organic matter which has been removed in the fossils. Similar sculpture occurs on the fragment of a tibio-tarsus described below. This peculiarity in the texture of the surface of the bone, taken together with the similarity of form of these femora with those of some recent birds, even in details of muscle attachment and of the disposition of the *lineæ asperæ*, seems to leave no doubt as to the avian nature of these remains.

A fairly exhaustive comparison of these portions of femora with those of various groups of recent birds leads to the conclusion that, so far as the evidence available goes, there is reason to believe that these extinct forms approach most nearly to the Steganopodes, e.g. the cormorant (*Phalacrocorax*). The points of similarity are (1) the form of the great trochanter, especially the strong forward prominence of its antero-external angle, (2) the position and depth of the muscle impressions on the outer face of the trochanter, (3) the fact that the summit of the head rises above the trochanter, (4) the large

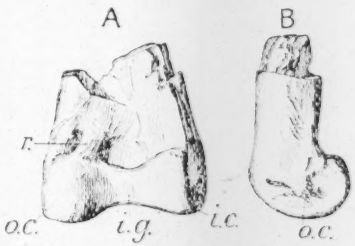


FIG. 2. Distal end of the right tibio-tarsus of (?) *Elopteryx nopcsai*. A, from front; B, from outer side. $\frac{2}{3}$ nat. size. *i.c.* inner condyle; *i.g.* intercondylar groove; *o.c.* outer condyle; *r.* outer ridge.

size of the pit for the *ligamentum teres*. Furthermore, the arrangement of the muscular ridges, at least in the upper part of the shaft, is closely similar to that seen in the Steganopodous femur, as is also the tendency to a backward flexure of the lower part of the bone. The bird represented by the remains just described was about as large as a pelican and is certainly different from any previously known form. I propose that it should be called *Elopteryx nopcsai*, gen. et sp. nov.

Another specimen which seems to belong to a bird is the distal end of a right tibio-tarsus (Fig. 2), including the articular region and about two centimetres of the lower end of the shaft; both the articular end and the shaft are strongly compressed from before backwards. The articular surface consists of two sub-equal condyles, the outer (*o.c.*) being a little the more prominent and convex; these are separated by a deep intercondylar groove (*i.g.*), bounded above by a narrow shelf of bone which forms the floor of a deep fossa at the lower end of the anterior face of the shaft. The condyles project very little posteriorly, and pass by a continuous curve into the flat or

very slightly concave posterior face of the shaft; the trochlear surface of the inner condyle (*i.e.*) extends a little higher up than that of the outer. The fossa on the anterior face of the shaft is bounded internally by a slight ridge, while on its outer side there is a strong flattened ridge (*r.*) running obliquely down to the upper border of the outer condyle, and perforated by a very narrow passage directed obliquely downwards and inwards. This passage is too narrow to represent the channel for the extensor tendons, present in most birds, and moreover is not in the right position. A similar foramen is present in many birds of very different groups, e.g. *Didus* and *Dinornis*; probably it transmitted a blood-vessel. The outer face of the external condyle bears a deep rounded fossa towards its anterior border, and behind this there is a narrow deeply cut pit, both probably serving for the attachment of strong ligaments. The inner face of the inner condyle is also excavated for the attachment of ligament, but the cavity is comparatively large and shallow. Above the inner condyle on the side of the shaft there is a roughened depression for the attachment of a muscle. No very closely similar form of tibio-tarsus has been found among recent birds. The fact that the condyles are nearly equal in size and that one does not project below the other separates this tibia widely from that of *Phalocrocorax*, and gives the impression that the bird was not adapted for swimming, but was ambulatory. It is of course uncertain whether this tibia belongs to the same bird as the femora described above, but from the close similarity of the sculpturing of the surface of the bone in the two cases it seems most probable that this is the case. If that is so, the resemblances found to exist between the femur of *Elopteryx* and that of *Phalocrocorax* lose some of their value, and it appears possible that the deep muscle impressions on the trochanter of the femur, though indicating a very powerful limb, do not necessarily point to an aquatic mode of life. Much more material must be obtained before it is possible to ascertain the affinities of *Elopteryx*, but that a large bird existed in Transylvania at the close of the Secondary period and in association with *Mochlodon*, *Telmatosaurus*, and other Dinosaurs is certain. It is not the occurrence of birds at this horizon that is remarkable, but the extreme rarity of their remains, while their complete absence from such deposits as the Purbeck and Wealden is still more extraordinary. The few remains that have been found in the later Secondary rocks show that the group was already highly differentiated, and in the Eocene probably all the chief orders now existing were already established.

II.—Notes on new or imperfectly known Chalk Polyzoa.

By R. M. Brydone, F.G.S.

(*Continued from the March Number, p. 99.*)

(PLATE VII.)

THERE are a number of simple Cheilostomata which develop avicularia distinctly larger than the zoœcia and more or less constricted in the middle by prominent masses apparently due to

infolds of the side walls. *Eschara Lesueuri*, Hag., sp.,[1] is a good example, and others have been figured by D'Orbigny. Similar forms are not uncommon in the English Chalk, but it is curious that all the foreign forms seem to be of branching Biflustrine habit, while all the English species I have yet met with form unilaminate sheets.

MEMBRANIPORA GRAVENSIS, sp. nov. Pl. VII, Figs. 1, 2.

Zoarium unilaminate, always adherent.

Zoœcia large, subpyriform, with distinct side walls and a variable amount of internal front wall, in consequence of which the areas vary from slightly elliptical to practically semicircular, but the lower lip of the area never becomes convex.

Oœcia helmet-shaped, large and wide, with a gently convex free edge.

Avicularia about half as long again as the zoœcia; above the constricting prominence they possess fairly definite side walls and front walls; these side walls thin away against the adjoining zoœcia, and their bounding sutures are very hard to trace; the front walls are fairly wide and very deep-set at the head, but narrow gradually and rise steadily towards the middle; the infold of the side wall starts a long way below the level of the upper end of the area, is bold and runs with a slightly convex edge obliquely inwards until it overlies the edge of the rising front wall, and then the two edges appear to run together, meeting a little further down and inwards; the junction is made into a small, rather brittle, projecting point by the sharp cutting-back immediately below it of the upper part of the mass, which then passes rapidly into a rounded side wall with a steeply sloping inner surface, which flattens out until at the foot the avicularium is subpyriform like the zoœcium; the area is naturally marked off by the constricting prominences into an upper and a lower section, the upper being much the larger. Avicularia are rarely developed until the zoarium has attained a considerable size, and it is therefore difficult to distinguish small zoaria from the mass of featureless specimens which it is customary to identify with some simple living *Membranipora*, but which are probably incapable of satisfactory identification.

This species is at present known to me only from the zone of *M. cor-anguinum* at Gravesend, where it is rather scarce.

MEMBRANIPORA SPARKSI, sp. nov. Pl. VII, Figs. 5–8.

Zoarium unilaminate, always free and foliaceous.

Zoœcia normally hexagonal and equilateral, with well-marked boundary sutures, thick flat walls, and slightly elliptical areas, but very variable at times both in shape and size; at the head of the zoœcium there is suddenly developed a narrow deep-set internal front wall, which is very characteristic.

Oœcia rare, but strong and well preserved, helmet-shaped and wide, with a free edge only slightly concave.

Avicularia very sparse in occurrence, of the same general type as in *M. Gravensis*, but with a strong tendency, both in external and

[1] Hagenow, *Die Bryozoa der Maest. Kreideb.*, p. 72, t. viii, fig. 17, and t. xii, fig. 12.

areal outline, to be long and parallel sided with pointed ends; at the head the side wall has a slight but definite thickness; the infold of the side wall has a concave edge, which never quite hides the edge of the front wall, and it can be clearly seen that these edges unite in the projecting point; the lower end of the avicularium is (in correspondence with the zoœcia) simple, not subpyriform; the upper and lower sections of the area are approximately of equal size.

The basal lamina is distinctive and apparently so constant in form as to be reliable for purposes of diagnosis, and I have figured a small piece.

This species is well distributed in the (restricted) zone of *A. quadratus* in Hants, and is abundant in Sparks' Pit, near Cosham.

MEMBRANIPORA CERVICORNIS, sp. nov. Pl. VII, Figs. 3, 4.

This species, which succeeds *M. Sparksi* very closely in time, is naturally very closely related to it, and is perhaps best described by enumerating the points in which it differs from that species. It is always adherent; the zoœcia have rounded side walls and no internal front wall; the avicularia and their areas tend to be short, broad, and round-ended, the front wall is very wide, the upper section of the area is smaller than the lower, and the constricting prominences stand up very strongly and have flowing outlines suggestive of those of a deer's antlers; no traces of oœcia have yet been observed.

This species occurs sparingly in the base of the zone of *B. mucronata* at Portsdown.

MEMBRANIPORA PLICATELLA, sp. nov. Pl. VII, Fig. 9.

Zoarium unilaminate, free or adherent, the free specimens showing a strong tendency to tubular branching shapes, as if they had incrusted seaweeds.

Zoœcia elongated, roughly hexagonal, with a considerable amount of internal front wall at the foot and bounded by definite sutures; areas of very variable size, but relatively small, roughly oblong, with gently convex sides.

Oœcia not yet observed.

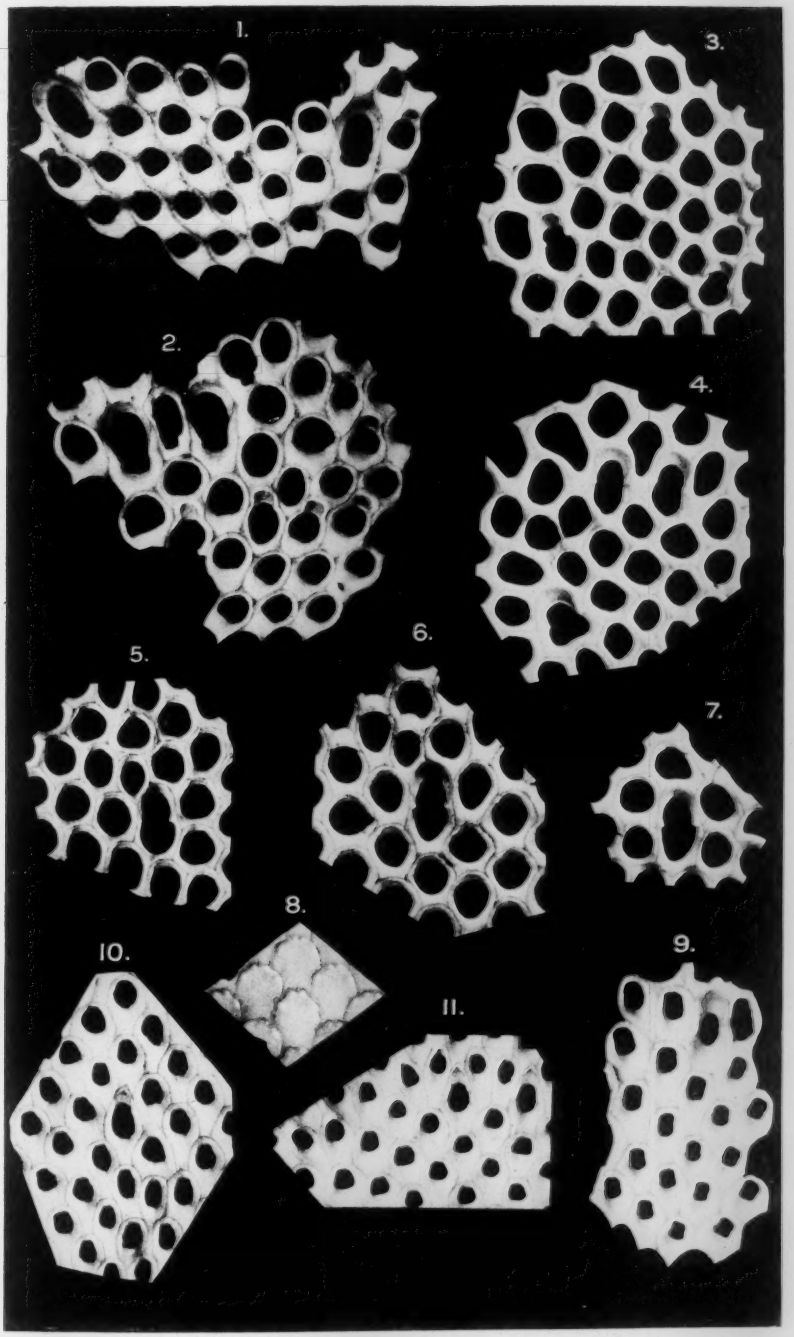
Avicularia relatively very large, of general *Lesueuri*-type; there is practically no distinction between front wall and side wall at the head, the two combining into a bowl-shaped ending; the edge of the infold of the side wall seems to split into an upper and a lower lamina, the upper one being cut back very early and dying out; the area is relatively very small, being little larger than that of the larger zoœcia, and narrowly elliptical, and the constricting prominences, which practically do not impinge on it, are median in position.

This species is fairly abundant at Trimingham.

MEMBRANIPORA ÆDIFICATA, sp. nov. Pl. VII, Figs. 10, 11.

Zoarium unilaminate, always adherent.

Zoœcia long and narrow, with flowing outlines and separated by faint sutures; areas very variable in size but relatively very small and situate quite in the upper half of the zoœcia, wide and flatly



R. M. Brydone, Photo. Benrose, Colls.

Chalk Polyzoa.

rounded at the lower end and narrowing gently upwards, usually with obtuse angles at the upper corners due to the arising of a very slight straight-edged internal front wall at the head.

Oœcia abundant, rather fragile, consisting of gentle helmet-shaped swellings with concave free edges.

Avicularia with very faint boundaries, rather modified from the general *Lesueuri*-type; the infold of the side walls starts well above the level of the top of the area and runs downwards with a straight edge until it impinges slightly on the area close to its upper end and forms the constricting prominence, which is thus exceptionally far up the avicularium; the cutting-back below is very slight, though discernible; upwards from the point where the infold starts the side walls are straight and well marked and slope inwards to meet in an acute angle, like roof timbers, so that the outline of the front wall is that of a cross-section through a simple building; the area is a narrow ellipse, and, as indicated, the upper section of the area is very small, the lower very large.

This species is well represented at Trimingham.

EXPLANATION OF PLATE VII.

(All figures × 12 diams.)

FIGS. 1, 2. *Membranipora Gravensis*. Zone of *M. cor-anguinum*, Gravesend.
,, 3, 4. *M. cervicornis*. Zone of *B. mucronata*, Portsdown.
,, 5, 7, 8. *M. Sparksi*. Zone of *A. quadratus*, Portsdown.
FIG. 6. ,, Zone of *A. quadratus*, Hensting, Hants.
,, 9. *M. plicatella*. Trimingham.
FIGS. 10, 11. *M. ædificata*. Trimingham.

III.—On *Lanieria*, Duncan, a remarkable genus of the Holectypoida; with a preliminary note on the tendencies of Echinoid Evolution.

By Herbert L. Hawkins, M.Sc., F.G.S., Lecturer in Geology, University College, Reading.

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1. Historical.

SOME time after the year 1850 d'Orbigny recognized, among a collection of fossils from Cuba, a species that he referred to the genus *Galerites* under the name of *G. lanieri*. The description and figures of the species were to have been included in vol. viii of the *Historia fisica, politica y natural de la isla de Cuba*, but the part of that work that should have contained them seems not to have been published.

It was not until 1881 that Cotteau ("Description des Echinides fossiles de Cuba," Mém. Soc. géol. Belg., vol. ix, p. 11, pl. i, figs. 7–13) gave a description of the form. He used d'Orbigny's

specific name of *lanieri*, and, with hesitation, included it in the genus *Echinoconus*, as the *Galerites* of previous authors was then called. As Cotteau himself remarked, the name of the fossil must be ascribed to him, as d'Orbigny's description was unpublished.

In 1897 Egozcue y Ciá gave a Spanish translation of Cotteau's description (Bol. Com. Map. geol., Madrid, No. 22, p. 9), giving a reproduction of the figures, and adding further measurements and a new locality for the species.

Duncan, in the *Revision* (1889), p. 168, very properly removed the species from *Echinoconus* and diagnosed a new genus, *Lanieria*, for its reception. It was, and is still, the sole species of the genus.

Cotteau, in the original description of the species, made use of several specimens (not all of which, unfortunately, belonged to the same genus), and gave figures of two. One of the figured specimens (Cotteau, loc. cit., pl. i, fig. 11), was in the Dewalque Collection, and is now in the British Museum of Natural History. In view of the confusion of forms described hereafter I hereby select this specimen (E. 4570) as the holotype.

There are five other specimens from the same locality and collection in the Museum. All of these were labelled "*Echinoconus lanieri*", and among them all the main features of Cotteau's description are included. However, only two of them (besides the type) belong to the genus *Lanieria*, the others being certainly referable to *Cœnholectypus*. It becomes necessary, therefore, to distinguish between the two types represented, and to free the diagnosis of *Lanieria* from the characters of *Cœnholectypus* with which it is encumbered. At the same time some further details of the structure of *Lanieria* can be given. The peculiar features of the genus raise a question of phylogenetic and morphological interest. I am preparing a more detailed study of this question as it affects the Irregular Echinoids, but the lines of argument are briefly put forward at the close of this paper.

2. Redescription of *Lanieria lanieri* (Cotteau), Duncan.

The three specimens of this species in the British Museum are registered as E. 4570 (the lectotype), E. 4571, and E. 4572. In the following description the first part is concerned solely with the type, additional features seen in the other specimens being added later. All the specimens are from the (?) Uppermost Cretaceous, Cienfuegos, Cuba.

E. 4570. Diameter 15·9, height 14·2 mm. at ambitus. Ambulacra 3, interambulacra 7 mm. wide. Diameter of peristome 4·8, of periproct 3·9 and 2·2 mm.; distance between peristome and periproct 1·8 mm. Diameter of apical system 0·8 mm.

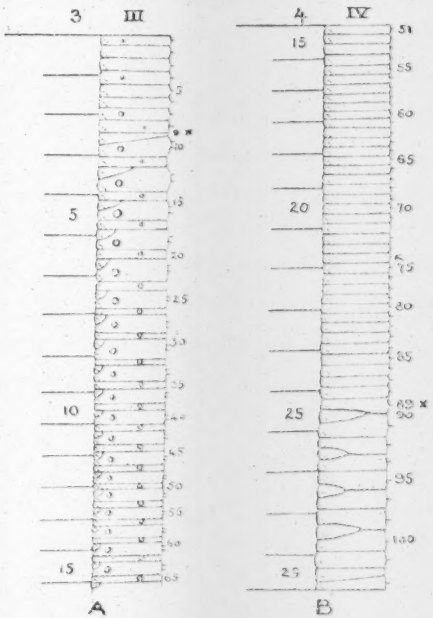
The *ambitus* is practically circular, and is situated about halfway between the apex and the peristome. The form of the test is almost globular, there being no appreciable flattening of the adoral surface. In fact, the specimen rests on the actual margin of the peristome, and on that alone, when placed with the adoral surface downwards. The test is very thin.

The *apical system* is central, approximately circular in outline, and projects slightly above the surrounding coronal plates. The sutures

between the plates are not very clear, but suffice to show that there are five large genital plates, each perforated by a large pore, and five small ocular plates minutely perforated. The madreporite is broken, but was central and apparently prominent, restricted, as usual, to the right anterior genital. The whole apical system is typically that of a *Cœnholectypus*.

The *periproct* is oval, and, although below the ambitus, is situated well up on the test, being inclined at an angle of about 45° from the horizontal. The outline is sharply pointed at both the adoral and adapical ends, the latter being slightly the more acute.

The *peristome* is small (compared with that of the Holectypinæ) and apparently quite circular. No indication of branchial slits can be seen, but the margin of the aperture is not very clearly exposed.



A. Diagram of adapical part of amb. iii of *Lanieria lanieri* [B.M. E. 4572].
B. Diagram of adoral part (not quite reaching to peristome) of amb. iv of *Cœnholectypus cubæ* [B.M. E. 11516].
The numbers refer to plates, counted from the ocular margin.

The *ambulacra* are straight and narrow. The pores of each pore-pair are slightly inclined perradially and adorally. Towards the peristome the pore-pairs become triserial in arrangement, but they seem to recover something of their uniserial plan when quite near the peristome margin. There are about four ambulacral plates to each interambulacral on the adapical surface, and apparently throughout. Only eight or nine primary ambulacrals intervene between the oculars and the 'crushing-point', and the full degree of crushing is

rapidly attained. The arrangement of the plates is similar in many respects to that found in *Conulus*. Of the three elements of a triad the adapical one is a narrow primary with parallel margins, the median one is an extremely minute demiplate (hardly extending perradially beyond the inner pore of its pair), and the adoral one is large, about twice the height of the adapical one. The perradial suture is zigzag for the length of about twenty plates from the apex, and then becomes almost straight. The main series of tubercles is situated on the large plates, near their adradial margins, and is persistent from apex to peristome. The second series is on the narrow plates, almost median, but becoming nearer to the perradial margin, and is persistent through most of the area. Both series of tubercles are of about the same size and are similar to those of the interambulacra.

The *interambulacra* are a little more than twice the width of the ambulacra. They are composed of about twenty-seven plates per column. The interradial suture is zigzag above, but becomes almost straight at and below the ambitus. The main tubercle series is not separable, in point of size, from the others. It is median on the adapical plates, but keeps at an almost uniform distance from the adradial suture throughout the column, thus appearing to pass down the outside of the area. The subsidiary tubercles that are between the two main series of an area are horizontally arranged, three or four on each plate near the ambitus. Those towards the ambulacra are in zigzag order—the principle of tuberculation being typically that of the Discoidiidæ. The surface between the tubercles is granulate. The test is somewhat worn adapically, but below the tubercles are seen to be in deep scrobicules.

E. 4571. A very large, crushed specimen. Diameter about 23, height about 21·5 mm. The ambulacra seem to have been slightly projecting above the interambulacra. The madreporite is very prominent.

E. 4572. A small specimen with an obscurely pentagonal outline. Diameter 13·6, height 11·2 mm. The periproct is broken, and the surface of the test weathered. The sutures are very clear, but surface ornament is largely missing. Genital 4 seems to be without a pore, but this is probably due to either abnormality or bad preservation. The ambulacra are well shown adapically, and part of the anterior area is diagrammatically shown in Fig. A. The sutures are obscure below the ambitus. There are about twenty-five interambulacral plates per column. Ten plates adapically, and about five adorally, are fairly high, but the middle region is composed of plates of considerably less height.

3. Description of *Cœnholectypus cuvieri*, n.sp.

The other three specimens that were associated with *L. lanieri* (Nos. E. 4574, E. 11516, E. 11517) belong to a species of *Cœnholectypus*. The "individu subconique et à la face inférieure plane; hauteur 11 mm., diamètre 19 mm." of Cotteau (loc. cit., p. 11) undoubtedly belonged to the same species. The variety Cotteau described (which is probably founded on the specimen mentioned above) is certainly a *Cœnholectypus*. The "face supérieure légèrement conique", "face

inférieure tout à fait plane", "pores ambulacraires . . . dans la région inframarginale . . . simples et directement superposées", are features exactly corresponding with those of the three specimens under consideration.

In one of them (E. 11516) the sutures are well shown, and the ambulacra are seen to consist of primaries from the apex to a point very near to the peristome. The first sign of 'plate-crushing' appears at No. 89 from the apex, while in *Lanieria* the corresponding point is about nine plates down. The diameter of this specimen is 18·5 mm., and its height 12·25 mm., and the periproct is only 1·4 mm. distant from the peristome.

The other two specimens seem to agree closely in all visible features with this one. No. E. 4574 is 18·5 mm. in diameter and 14·5 mm. high, while No. E. 11517 is smaller and less well-preserved. The form appears to be new, and I select No. E. 11516 as the holotype. The systematic summary of the species can be expressed as follows:—

Cœnholectypus cubæ, n.sp.

Syn. *Echinoconus lanieri*, var., Cotteau, 1881, Mém. Soc. géol. Belg., ix, p. 11.

Horizon: ? Uppermost Cretaceous, Cienfuegos, Cuba.

Type: e coll. A. H. Lanier, in British Museum.

4. The family Lanieriinæ, nov.

As will be seen from the description, the characters of *Lanieria* are anomalous and in some ways synthetic. The apical system and tuberculation are definitely like those of *Cœnholectypus*, while the general proportions of the test, and particularly the structure of the ambulacra, conform more to the type of *Conulus*. The two latter genera are strikingly different from each other, and are probably the results of an early separation in phylogeny. It is therefore unlikely that *Lanieria*, occurring in deposits of presumably Upper Cretaceous age, can represent a truly intermediate stage between them.

To my mind the characters of the apical system are less likely to be suddenly or irregularly modified than those of the ambulacra. The former structure is completely developed early in ontogeny, while the ambulacra are continually growing (in the Holectypoida) throughout life. It is therefore possible that some comparatively trifling change could cause 'plate-crushing' to appear in the ambulacra, whereas fundamental and complete modification would be necessary for the development of a fifth genital and gonad.

It seems likely, therefore, that *Lanieria* is a peculiarly specialized offshoot from the Discoidiidæ, and has no direct phylogenetic connexion with *Conulus*. In a recent paper (Proc. Zool. Soc., 1912, p. 450) I included *Lanieria* among the Holectypinæ (by error as a sub-genus of *Holectypus* on p. 477), but had not then seen a specimen. In view of the remarkable ambulacral features, it seems best to place it in a separate sub-family of the Discoidiidæ, which may be called the Lanieriinæ.

Another genus, *Discholectypus*, Pomel, which I regarded as "*incertæ sedis*" in the paper above referred to, can join *Lanieria* in this sub-family. *Discholectypus*, whose type is *Holectypus meslei*, Cott., Peron,

and Gauth., from the Lower Cretaceous of Algeria, resembles *Lanieria* in its ambulacral complexity, and is otherwise closely similar to *Cœnholectypus*. I have not seen a specimen, but the figure given by Cotteau, Peron, and Gauthier (*Ech. foss. Algérie*) shows the ambulacra to be even more like those of *Conulus* than are those of *Lanieria*. The adapical member of each triad, instead of being a thin lath with parallel edges (as in *Lanieria*) is wedge-shaped, being pinched at its perradial end.

The systematic position of these two genera may be summarized as follows:—

HOLECTYPOIDA. DISCOIDIIDÆ.
LANIERIINÆ.

Two genera. *Lanieria*, Duncan. *L. lanieri*, type.
Discholectypus, Pomel. *D. meslei*, type.

5. THE BIOLOGICAL SIGNIFICANCE OF THE LANIERIINÆ.

Assuming that the foregoing systematic association of the Lanieriinæ with the Discoidiidæ is correct, an interesting feature in morphogenesis is presented. The peculiar ambulacral structure of *Conulus* (which is continued, probably by direct descent, in *Echinoneus* and *Micropetalon*), although obviously connected with the usual structure of the Holectypoida, is so definite that it would be thought to be a special development not likely to be repeated independently.

Excluding *Amblypygus* from the discussion (for this genus may possibly be an Echinoneid, though apparently closely related to the Echinolampidæ), we find that '*Conulus* structure' has appeared three times in the history of the Holectypoida. In one case, *Discholectypus*, the ambulacral complexity is unaccompanied by any other similarity to the *Conulus* type, while in *Lanieria* the general facies of the test (although no other detail of structure) conforms to that of *Conulus*. It seems impossible that *Discholectypus* and *Lanieria* can be in direct phylogenetic sequence, taking into consideration their distant and restricted localities and widely separate horizons. Further, the nature of the ambulacral plating does not, in this case, seem at all to be connected with any adaptive purpose. Except, perhaps, near the peristome, there is no actual increase in the number of plates (i.e. podia) achieved by the 'plate-crushing'.

In the independent development of this peculiar structure in at least three distinct types of the Holectypoida we seem to find an expression of some fundamental tendency in evolution which, within the limits of an order, can cause one set of structures to be developed, without regard to the others, on a definite plan. It may be suggested that there is an objective, or goal, towards which the evolution of a group is tending, and which may be reached independently, and piecemeal, by various members of the ramifying series of the group.

Expressing this phenomenon in somewhat 'diagrammatic' language, one may suggest that at the inception of an order the first member is a complex association of parts in definite stages of development; and for each part there is a certain ideal line of evolution along which, as far as possible, it will travel independently towards a certain limit. The succeeding members of the order will be composed of the same

parts as their progenitor, but these parts will be in diverse stages of evolution, some having progressed rapidly, others slowly, some having remained stationary, and others having been retrogressive.

Acceleration and retardation become, then, as important factors in phylogeny as they are recognized to be in ontogeny, and, as in the latter case, concern the separate parts of the individual rather than the complete organism.

To sum up, the true phylogenetic position of a genus (or any other rank) can be expressed only after its features have been separately analysed and their various stages of progress appreciated. The conception can be made clearer by thus expressing (for a few characters) the relative positions of *Lanieria*, *Discholectypus*, and *Conulus*.

Structure.	Ambital Outline.	Apical System.	Ambulacra.	Interambulacral Ornament.
Trend of evolution in Echinoidea Irregularia.	Circular→ Cordiform.	Broken→ Restored.	Simple→ Compound.	'*Pygaster*-like'→ Uniform, granular.
Lanieria . . .	R	A	A	Ra
Discholectypus . .	R	A	A	Ra
Conulus . . .	Ra	rA	A	rA

R = retarded evolution. A = accelerated evolution.
Ra = retarded, but slight progress. rA = progress, but not complete.

In tracing the condition of phylogenetic development of a group it is necessary, then, to have regard to three points: (1) an analysis of the individual and a 'diagnosis' of each separate structure; (2) a knowledge of the corresponding features of the original member of the group (sometimes available, often partly hypothetical); and (3) a knowledge of the ultimate possibilities of each structure in the course of its evolution (hypothetical, but to be roughly ascertained by considering the most highly developed conditions found in the group). Care must, of course, be taken to eliminate, as far as possible, conditions which are the direct results of adaptation to environment.

IV.—The Upper Trias of Leicestershire.

By A. R. Horwood.

(*Continued from the March Number, p. 121.*)

(5) *The Rhætic Outcrop.*

ALTHOUGH the Rhætic beds are not exposed continuously along the eastern boundary of the Keuper outcrop, they have been proved at many points from the River Trent in the north on the

Nottinghamshire border to Glen Parva in the south. South of this point there is so much drift, and borings within the Liassic outcrop have been so isolated or shallow, that there is a gap in our knowledge of the intervening ground between the last point and the Rugby district. The Countesthorpe boring, carried to a depth of over 600 feet, encountered Upper Keuper beneath the Drift, with no intervening Rhætics. Commencing in the north in the Gotham district the two outliers are capped above the Red Marl and Tea-green Marl with Rhætic beds, and Lower Lias Limestone (*Ps. planorbe* zone) above. At Ash Spinney at the south end of the southern outlier, and at the east end of Crownend Wood, Black Shales with *Avicula contorta* crop out; and on the west side septaria are seen. On the north-west side of the northern outlier at Cottager's Hill *Protocardium phillipianum* has been found in a well-section near the lane. Rhætic shales are seen in the shafts driven for gypsum works about Gotham. To the south, at East Leake, in the railway cutting through Normanton Hills at the south end of the tunnel, there was formerly a good section showing Lower Lias and Rhætics faulted against New Red Marl, with a very sharp line of division, a continuation of the Hoton fault, which is extended in a north-west direction to Castle Donnington, between which two points the Soar Valley obscures it; but it cuts off the Lower Keuper at Hemington, bringing the Red Marl to the surface.

A section measured opposite the fault where the beds became more horizontal showed:—

		ft.	in.
Lower Lias (*Planorbis* zone).	Stone	0	2
	Shales	0	1
	Stone	0	9
	Shales	1	7
	Stone	0	9
	Shales	2	4
	Stone	0	5
	Shales	1	6
	Stone	0	6½
	Shales	0	1
	Stone	0	2
	Shales	0	1½
	Stone	0	2
	Shales	0	2½
	Stone	0	0½
	Fissile pyritic stone, parted by way-boards of shale (¼ inch), partly conjoined with the next	0	4
	Shales	0	2
	Stone with *Ostrea liassica*	0	4½
	Shales below nodular limestone	0	5
	Shale	0	9
	Nodular limestone	0	9
	Upper Rhætic shales	9	0
	Nodular limestone	1	0
	Lower Rhætic shales	24	0
	Tea-green Marl	16	6
		62	2½

In a section Browne drew up for the Ipswich meeting of the British Association he gives the following section:—

	ft.	in.
Upper Rhætic shales	7–12	0
Limestone	0	6
Lower Rhætic shales, dark-grey	12	0
Lower Rhætic shales, rusty-black (*Isodonta*, *Myophoria*)	2	0
Sandstone, pyritous	0	1
Shales, black	1	3
Shales, black, hard band	1	0
Thickly laminated shales	5	0
Sandstone, with galena, pyritous	0	2
Black shale	1	2
Upper Keuper Tea-green Marls	16	6
	51	8

A section on the west side, north end, showed Red Marl on one side of the fault with two skerries below a thick bedded sandstone above. Tea-green Marls are shown squeezed in between this, and the Rhætic and Lias. Another section showed Lias with two beds of limestone at the Loughborough or south end of the tunnel, rising to the north above Upper Rhætics with a band of White Hur below, and Lower Rhætic beneath it.

An interesting suite of fossils was obtained here (see Palæontology). Mr. W. T. Tucker found a piece of bone-bed, 2 inches thick, "stuffed full of bones, scales, and similar to the Aust breccia." About 10 feet above the Tea-green Marls a fish-band was found, also coprolites, vertebræ, and teeth. He also noticed a nodular band 30 feet below the first Lias grey nodular band, with 20 feet black shales beneath it. If so, the Rhætics here were 50 feet thick.

At the junction between the Tea-green Marls and the black shales there was a yellow band, but no regular bone-bed. The Tea-green Marls showed traces of erosion. At the north end of the tunnel the dip was 6° to the south. At the south end it was 2°–6°.

To the east at Costock at Flint Farm in the stream section flinty limestone is exposed, and some pits about here were formerly worked for limestone. To the south at Rempstone flinty limestone occurs at Sutcliffe Hill, and where the outcrop crosses King's Brook. The Stanford fault shifts the outcrop again to the west, and about Stanford Hall in the trough high ground is probably formed by these beds. Between Walton and Barrow, in the valleys cut through the Drift and Lower Lias, the Rhætics have been exposed on each side of the brook, and the outcrop is continuous between here and Walton, black shales being struck in a well 500 yards west-south-west of Walton Church. The outcrop continues westward from here to Barrow Hill.

H. B. Woodward[1] recorded the occurrence of Rhætics at Barrow-on-Soar, and remarked that "above the black shales there was a considerable thickness of apparently unfossiliferous grey earthy

[1] Ansted (1866) noted them earlier.

marl, capped by a hard bed which I took to represent the upper limit of the Rhætic formation. Above it the ordinary Lower Lias limestones and clays come on".

Laminated lumpy shales overlying Tea-green Marls have been exposed in the Midland Railway cutting 600 yards north-west of the station. South of Barrow at Netherfield grey shale and nodular limestone was found with a dip of 12°, accentuated by the Barrow and Sileby fault. At Barrow Hill black shales and a bone-bed overlaid Tea-green Marl.

To the south, in the Wreake Valley, Lias comes on directly against Red Marl owing to the Sileby and Barrow fault, which causes a displacement of the beds to the west, and in a well-sinking at Ratcliffe Boulder-clay (80 feet) rests on Red Marl, showing they are absent here. The lowest beds of the Lower Lias are seen to the east at Kirby Bellairs, so that the fault runs north of the Wreake Valley.

In the boring for water at Melton Rhætic black shales and a nodular limestone 16 ft. 4 in. thick rest on 247 ft. 10 in. of Red Marl, with sandstone near the base, and gypsum beds.

At Brooksby Red and Grey Marls are found up the Wreake Valley, indicating the extension of the Rhætics so far east. In the stream-side between Queniborough and Gaddesby Grey Marls and mottled clays are exposed, and further south near the village east of the new hall Grey Marls are seen along the slopes. In the brook at Barkby and half a mile from the village Grey Marls are also exposed, as well as in fields. At the New York Farm on the Ridgemere road, black shales were met with for 52 yards. Paper shales have been exposed on the ridge north of the fault at Barkby-thorpe, which makes a bold escarpment.

At Humberstone the Rhætic beds have been exposed at various points and pierced by borings and well-sections to the east of the Spinney Hills in the low ground between the latter and Crown Hills from Evington Road to Uppingham Road. The shales were struck in the boring at Lodge Farm (2) and appear in the other adjacent or Crown Hill borings (16 ft. 9 in.), but were absent in the Willow Brook boring. They crop out in the Humberstone drive, where Lower Lias beds succeed them. The well-boring at the Asylum pierced Lias and 20 ft. of Rhætics with nodular limestone. The nodular septaria were recently met with in a well in Freeman's Road North below river gravels, and the slopes at the junction of Green Lane and Coleman Road are in Rhætic shales.

At the top of the Gipsy Lane Pit, on the east side, thin bands of black shales succeed a thick section of Tea-green Marl. At their junction I found *Estheria minuta*. In a small pond in a field to the east they are again exposed. Following the hillside they run in a north-east direction to a point just north of the Humber Stone, where in a ditch the line of fault brings the Red Marls against the black shales in the second field on the Humberstone and Barkby-thorpe bridle-road.

In an excavation for St. Philip's Church 2 feet of Rhætic shales were encountered beneath 9 feet of soil and drift. In Green

Lane Road 2 feet of shales were found in a well-section under 8 feet of soil and drift, and they outcrop in the ditch on the west side.

There has been some discrepancy as to who first discovered the Rhætic beds at Leicester. Mr. J. J. H. Teall, F.R.S., reported their occurrence here in 1874, but they were not then actually recorded. Later on Mr. W. J. Harrison described them in 1876 in the Report of the Geological Section to the Leicester Literary and Philosophical Society.

The section of Rhætics at the Spinney Hills, now built over, was described by W. J. Harrison in 1876. Then three brick-pits were situated on this ridge, which forms the Rhætic escarpment between Humberstone Road and Victoria Park. The valley between has been excavated, and only the Tea-green Marls are visible, but eastward the Rhætics come on again. The floor of the pits was in Red and Blue Keuper Marl (10 feet) with selenite and salt pseudomorphs. He notes the diminished thickness of the red bands at the top of the Keuper. There are about 16 feet of Tea-green Marls below the Rhætics here, which are black shales about 10 feet thick. The higher beds with a second nodular limestone were noticed in other excavations.

The section here (Moore's Pit, junction of Wood Hill and Prospect Hill) was:—

		ft.	in.
	Soil and drift, with flint implements and Roman pottery, etc.	1	0
Lower Rhætic.	Nodular band of limestone, with casts of *Estheria*, *Avicula contorta*	0	6
	Light-coloured shales, with sandy partings, *Modiola minima*, *Avicula contorta*, *Cardium rhæticum*	4	0
	Dark shales, with sandy partings, *Ophiolepis damesii*, *Pholidophorus mottiana* (= *higginsi*)	1	0
	Finely laminated black shales, *Avicula contorta*, *Cardium rhæticum*	2	0
	Sandstone = *Axinus* bed, worm-tracks	0	1
	Black shales, coarsely laminated	2	6
	Bone-bed, *Gyrolepis*, *Saurichthys apicalis*, *Hybodus minor*, *Ceratodus*, *Nemacanthus monilifer*, *Ichthyosaurus*, *Plesiosaurus*, *Sargodon tomicus*, etc.	0	3
Upper Keuper.	Light-buff sandy shales with hard courses, bluish nodules on lower part, fish scales	16	0
	Red and Blue Upper Keuper Marl	10	0
		37	4

The upper surface of the Red Marl was uneven, hollowed out in long curves. The dip was south-east. The Tea-green Marl was green in parts, with blue nodules in the lower part, fissured, and with conchoidal fracture. Selenite occurs in it, and pseudomorphs of salt crystals, as well as ripple-marks. Fish-scales are numerous. I have examined these, and they are of the Semionotoid type. In the same material *Estheria minuta* is abundant. Teeth also occur. Mr. Harrison said he found a single insect wing here, but I think this must have been *Estheria*, as he said it perished on exposure, a feature common to *Estheria*. The upper surface was uneven.

Rain pittings were abundant. In the unweathered state the bone-bed is hard, but the contents brittle. Harrison obtained from here large vertebræ of *Ichthyosaurus*, rib bones belonging to *Plesiosaurus* (one 18 inches), and Labyrinthodont bones, worn and rolled bones, coprolites containing small quartz pebbles and bits of Dane Hill Sandstone. Pebbles are mainly quartzose or of slate, and rounded; some 3–4 inches, of local origin. *Isodonta* occurs loose in the bone-bed. The Pullastra Sandstone is reddish, and ½–1 inch thick.

The first British example of *Ophiolepis damesii* was found here, but others have recently been found elsewhere. It is probably dimorphic, with a large and small form. Recently fine large types have been found at Glen Parva, as well as the smaller type. Both were regarded by Wright as belonging to this species. Kaolinite, bitumen, selenite, and mica are common in the dark shales with sandy partings. In the nodular limestone the *Estheria* occurred with *Avicula* on the outside. Harrison says a second bed occurs 2 feet above the last, and light-coloured clay and sand above, as seen in the section described by Bates & Hodges. He mentions the occurrence of Rhætics in an exposure on the Great Northern Railway near Crown Hill, where beds of limestone ('Firestones' and 'guineas' of Warwickshire), and a thick bed, probably true White Lias, are said to have been met with. He also states that on the Leicester and Wigston line a section showed the Rhætics had been eroded.

Mr. Browne, in his detailed *History of the Geology of the Borough of Leicester*, gives a most valuable series of sections in the Spinney Hill district, where Rhætic beds were formerly met with. It is unnecessary to discuss these further here, especially as the whole district is now entirely built over.

Messrs. Bates & Hodges gave an account of a section from Diseworth Street to St. Peter's Road in which Lower Lias and Upper Rhætics were exposed, showing 11 ft. 1 in. of the latter with *Isodonta ewaldi*. Other sections in the district show that the Rhætics of the Spinney Hills were thinner than at Wigston. There is here no trace of White Lias, and in all essential characters the Leicester exposures closely resemble the beds at Glen Parva, where again Upper Rhætic is followed by Lower Lias without any intervening White Lias.

From the Spinney Hills the Rhætic beds are continuous across Victoria Park to Clarendon Park and thence to Knighton village, where the Upper and Lower Rhætics have been exposed in shallow sections near the church and in the lane. The black shales also are seen in the valley at the surface, and form a fairly wide outcrop above Tea-green Marls. Southward recent sewer excavations between here and Little Wigston have exposed the lowest beds of the Lower Lias and Rhætic Shales. They have also been found to underlie Liassic beds at Gold Hill Farm, whence the outcrop is obscured by Drift, so that in the Midland Railway cutting they are not exposed at the bridge. From this point, close to the Wigston and Aylestone Road, it turns due west, till just east of Aylestone Grange, where, still obscured by Drift, it strikes due south to the Glen Parva Barracks, where it again turns to the east and is exposed at the

station, a fine section (80 feet) from Keuper to Drift, including Lower Lias, having been excavated for brickmaking. The shales are seen in the railway embankments to the north-east at the base.

Messrs. Wilson & Quilter [1] were the first to describe this section in detail, and this summarized was as follows:—

	ft.	in.	
Boulder-clay	8	0	(to 27 feet).
Lower Lias	1	0	
Upper Rhætics (called White Lias)	22	5	
Lower Rhætics	17	10	
Tea-green Marl	15	5	
Red Marl	14	6	
	79	2	(to 98 ft. 2 in.)

They note the fact that there is no true bone-bed, but an evanescent seam of white sand, with scattered teeth, coprolites, etc. From the Lower Rhætics they record *Isodonta ewaldi*, *Protocardium philippianum*, *Avicula contorta*, *Gyrolepis*, *Acrodus minimus*, *Hybodus minor*, *Saurichthys*, *Nemacanthus*. They found the cast of a single ray of *Ophiolepis damesii*, but not in situ. They report fish-remains at a definite horizon, 3 ft. 6 in. to 3 ft. 9 in. above the bone-bed. They found the junction between the Tea-green Marl and Black Shales sharp, but the beds conformable. The former are referred to the Keuper, into the Red Marls of which they imperceptibly graduate. The Lower Lias in a smaller pit was found to consist of 1 ft. 9 in. of flaggy limestones and shales, and above 7 feet of laminated blue shales. The dip was two degrees to the north-west. The existence of a small fault [2] was noticed.

In a later paper Quilter speaks of the Tea-green Marls as eroded at the top. The *Gyrolepis* is referred to *G. tenuistriatus* (= *G. albertii*), and the *Saurichthys* to *S. apicalis* (= *S. acuminatus*). *Pecten valoniensis* is added to the list of fossils in the Black Shales. The yellow blue-hearted nodular limestone at the top is regarded as equivalent to the "sun-bed". In a later paper the same writer adds *Pholidophorus nitidus* to the list of fossils in the Black Shales, and appends a list of fossils found in the Rhætics of Leicestershire, including those found by Harrison, adding *Plicatula intustriata*.

Dr. A. S. Woodward examined some fish-remains obtained by Mr. A. E. Baker from the Spinney Hills, which included *Hybodus minor*, *H. cloacinus* (new to Britain), *Acrodus minimus*, *Nemacanthus*, *Sphenonchus*, *Gyrolepis albertii*, *Sargodon*, *Saurichthys acuminatus*, and *Ceratodus latissimus*. Some fish from Wigston obtained by Wilson are assigned to *Pholidophorus nitidus* (a small form of *P. higginsi*). This was obtained in cores from the Evington boring with *Avicula contorta*, etc.

In 1891 M. Browne, from material in the Baker Collection from Spinney Hill, identified *Ctenoptychius ordii* as the worn basis of

[1] J. Plant (1866) noticed the occurrence of Rhætic beds on the Leicester and Nuneaton line in 1863.

[2] A similar fault is shown in the section at Diseworth Street, east of Spinney Hills.

a tooth of *Hybodus minor*, and *Sphenonchus* as belonging to the same. He suggested *Sargodon tomicus* resembled shed tubercles of fin spines of *Nemacanthus monilifer* (= *Hybodus minor*).

The next description of this section was by M. Browne (1901). He remarks that the Lower Rhætic upper limit is generally taken as the second limestone (from below), but he prefers to take the first one or just above it as the junction with the Upper Rhætics. He suggests that at 2 ft. 8 in. a rust-coloured band may represent a second bone-bed, as at Aust. Above this the beds are more fissile, crowded with *Isodonta*. The first limestone band, he says, is 90 per cent carbonate of lime, but this is an over-estimate, as it is largely detrital in origin. The Upper Rhætics contain only Annelid burrows above the second limestone, which is said to contain *Estheria minuta*. A curious statement is made to the effect that a persistent band of limestone nodules above the second thick nodular bed "ends the true Rhætic". The occurrence of radiating gypsum is noted for the first time. The yellowish limestone is said to be Lower Lias above, "Sub-Lias = White Lias" below. *Colobodus*, described at the Brit. Assoc., 1891, is recorded from the bone-bed. He remarks that both Tea-green and Red Marl might reveal traces of fish-scales, and teeth of sharks in the sandstone and skerries. He notes that the Tea-green Marls are 20 feet, not 15 ft. 5 in. as given by Quilter. He correlates the Sub-Lias with the *Ostrea* zone, and this obviously with the White Lias. He says the compound rock was 3 feet in the north-east part of the pit, and at the top contained Liassic fossils. He also says the limestone resembles Cotham Marble and White Hurs of Barrow-on-Soar, and that nodules in the lower part may be the White Hurs = in part the "Cotham Marble"; and probably that the Fourfoot Lower Lias Limestone "is represented at the top of the thick stone". To the south the Ironstone of Barrow-on-Soar is interstratified with this "compound rock", which occurs at the base of the Fourfoot Limestone. He notes that the Fourfoot or good-for-nothing Limestone occurs in the pit to the south-west curiously pitted with raindrops or Lithodomi, and contains *Ps. planorbe*. Unlike Wilson and Quilter, he does not confound the Upper Rhætics and White Lias, but regards beds above his Upper Rhætics as "Sub-Lias". L. Richardson later redescribed this section, with critical notes on the above correlations. At the time, I must say, I agreed with the main portions of his description and measurements, but having had occasion to remeasure the section, I find that my own are slightly different. Richardson draws the line between the Upper and Lower Rhætics at 10 ft. 7 in. from the top of the former, relying on the unfossiliferous nature of the Upper and the yellow colour of the shales as distinctive features for separating them from the Lower. The bottom part of the compound bed forms the top of the Rhætics, and the Upper the base of the Lower Lias if not divided by marls. He considers there is a non-sequence between them, as between the Tea-green Marls and the bone-bed, since elsewhere Sully Beds intervene, though here the two are conformable. He estimates the Tea-green Marls at 12–15 feet, but I find the estimate of 20 feet given by Browne more correct. He says "now it is at, or may be a few inches below, this limestone bed

that I would draw the line between the Lower and Upper Rhætic", that is, the second limestone band. But in the section the line is drawn 9 ft. 3 in. above this bed. He reiterates the statement that the Lower Rhætics here are characterized by absence of hard bands. My own examination resulted in the discovery of several hard but thin beds of gritty or pyritic sandstone. The Upper Limestone is compared by Richardson to bed 9 at Langport and elsewhere. He thinks the *Ophiolepis damesii* bed should be 2–3 feet below the Lower Rhætic bed. There are two horizons for it at Wigston, as will be seen. He does not credit the record of *Estheria* in these limestone beds by Browne, but it must be remembered Harrison found them on the outside of the same beds. He draws attention to the wrong correlation between the *Ostrea* bed and the White Lias. If the lower part of the compound bed is equivalent to Cotham Marble, then the top is the *Ostrea* bed, Insect and Crustacean bed or White Lias of Mid-Somerset, but he thinks the compound bed is equivalent to the *Pseudomonotis* bed of Garden Cliff.

My own examination of the pit is summarized in the following section. The palæontology is dealt with elsewhere. Messrs. A. J. S. Cannon and Siddons have made important discoveries here, some of which have already been described, whilst others are reserved for the conclusion of this paper.

		ft.	in.	
	1. Drift, sand, and gravel . .	6	0	(to 2 ft. 3 in.)
Lower Lias (*Ps. planorbe* zone).	2. Laminated dark shales, weathering grey, with a blue line near the top, iron-stained, weathering light brown	1	0	(to 1 ft. 2½ in.)
	3. Dark-greyish blue-centred limestone, flaggy above, and below massive in the centre; crushed crystalline limestone, in thickest part, compound, consisting of dark-blue and light-grey variegations, false-bedded, dipping south. At the top in the deepest part resembling blue-hearted nodular beds, layer 1 inch thick, bored by vertical worm-tubes (cf. Browne)	0	4½	(to 1 ft. 2 in.)
	4. Stiff yellowish-brown nodular marl with ironstone streaks, coated with manganese	0	5	(to 1 ft. 4 in.)
Upper Rhætic.	5. Blue-hearted nodular limestone, with veins of calcite 5 inches, continuous in places, elsewhere broken. In part double, with a marly layer between . .	0	5	(to 1 ft. 0½ in.)
	6. Brownish nodular marl . . .	0	8½	
	7. Blue nodular limestone, with iron-stained band at base . . .	0	1	
	8. Blue laminated shales, with a band of pyritic nodules at the base, and 5 feet above the base a rust band	11	0	
	Carried forward . .	20	0	

			ft.	in.	
		Brought forward . .	20	0	
Lower Rhætic (*Avicula contorta* zone).	9.	Bluish laminated shales, with two rust bands 6 inches, and 2 feet below the last, with a hard thin indurated band ($\frac{1}{2}$ inch) 6 inches above the base, and a thicker band ($\frac{3}{4}$ inch) at the base, with fine selenite crystals . . .	4	0	
	10.	Bluish laminated shales, with sandy partings	6	0	
	11.	Thin septariform band, irregular, with so-called sandy parting, which here is rotten septaria, and thin bluish shale below .	1	0	
	12.	Very finely laminated shales, and band of nodular limestone at the base	1	0	
	13.	Finely laminated blue shales .	2	0	(to 3 ft. 4 in.)
	14.	Thick uniform band of septariform nodular limestone . . .	0	5	
	15.	Thickly laminated earthy grey-blue shales, with a band of sandstone ($\frac{3}{4}$ inch) at the base, and three or four sandy partings . . .	1	9	
	16.	Grey-blue thickly laminated clay, with pyritic bands ($\frac{1}{4}$ inch) at the base	2	0	
	17.	Bluish-grey thickly laminated shales, with thin pyritic nodular bands, commencement of septariform nodules . . .	2	8	
	18.	Shales similar to 17 . . .	4	9	
	19.	Nodular band	0	3	
	20.	Thickly laminated blackish shales, with line of thin gritty sandstone at base (*Isodonta* bed) . .	2	1	
	21.	Similar to 20, with rust band at base, but more fissile and sandy	1	7	
	22.	Thinly laminated fissile paper shales, with numerous fossils .	2	10	
	23.	Bone-bed	0	1	
	24.	Tea-green Marls, with eight nodular bands and fish horizon 3–4 feet from the base, another 1 foot from the base, or with basal line of fish-scales, worm burrows 2 feet from top, *Orbiculoidea Townsendi* 5 feet from top .	20	8	
	25.	Pink marl	0	8	
	26.	Green marl, with fish-scales .	0	5	
	27.	Red nodular band	1	9	
	28.	Pinkish-green nodular marl . .	0	4½	(to 5 inches)
	29.	Red or pink marl merging into 30	0	6	(to 1 foot)
	30.	Greenish-pink or purple marl .	0	6	(to 8 inches)
	31.	Pinkish-purple marl	0	8	
	32.	Green marl	0	3	(to 4 inches)
	33.	Red marl	1	0	
	34.	Gypsum	0	6	
			79	8½	(to 101 ft. 9 in.)

It will thus be seen that the different beds examined in detail are far from being so uniform as is generally assumed. The total thickness has also been under-estimated.

Reference has been made to the Crown Hill boring, where 16 ft. 9 in. Rhætic beds, including Tea-green Marl, are said to have been met with. The base is given as at 205 ft. 10 in., and the top at 189 ft. 1 in. But cores at 163 feet are apparently in Rhætics, and the junction with Lower Rhætic occurs probably at 176 ft. 10 in., and at 182 ft. 1 in. the beds are black and contain *Avicula contorta* and *Pecten valoniensis* between this and 187 ft. 3 in. A core marked 174 ft. 0½ in. contains the latter also. The Tea-green Marl, in fact, commences at 189 ft. 10 in. and continues to 202 ft. 9 in. There are thus 39 ft. 9 in. of Rhætic and Tea-green Marl, and 26 feet of Rhætic. *Gyrolepis* scales occur at 192 feet in Tea-green Marl. *Pholidophorus higginsi* was obtained in the Black Shales.

In a boring at Billesdon near the brook below Frisby, beds between 648 and 716 feet are probably in Rhætics, *Avicula contorta* occurring in the last 5 feet, above 15 feet of Tea-green Marl and 238 feet of marly sandstone with thin gypsum beds. If these thicknesses are correct the beds are thicker between Melton and Leicester, and as well developed as at Newark.

(To be continued later on.)

V.—On the Discovery of Fossil Plants in the Old Hill Marls of the South Staffordshire Coal-field.

By E. A. Newell Arber, M.A., Sc.D., F.G.S.

IT is unfortunately true that our present knowledge of the fossil flora of the South Staffordshire Coal-field is lamentable, considering its size and importance and the abundance of fossils which it is known to contain. All that has been recorded from this coal-field is contained in a single paper by Dr. Kidston,[1] published twenty-five years ago, on the fossil plants of the Hamstead boring, with the addition more recently of a scanty list of fossils from the Langley Green boring,[2] and some other special studies on certain particular fossils, such as *Crossotheca* and the fructification of *Neuropteris*. Prior to these records Hooker alone appears to have described plants from this coal-field.

I have been hoping for some years past to do something to remedy this sad state of affairs, and a beginning has been made. I am now able to announce that my friend Mr. Henry Kay, F.G.S., of Birmingham, has quite recently discovered a large number of well-preserved plant remains in the Old Hill Marls, or rather in beds of grey clay or clunch interbedded with the red marls. This important discovery, which is due to Mr. Kay's skilful and patient collecting, helps to fill a gap in our knowledge of the plant succession in this coal-field. The beds in question occupy a perfectly definite position in the Coal-measure sequence. These "Red Coal-measure Clays" of Jukes lie intermediate between the Productive Grey

[1] Kidston, Trans. Roy. Soc. Edinb., vol. xxxv, pt. vi, p. 317, 1888.
[2] Kidston, Summ. Prog. Geol. Surv. for 1905, p. 174, 1906.

Measures below and the Halesowen Sandstone group above. The locality from which Mr. Kay obtained the specimens, which he has kindly placed in my hands for description, is the Granville Clay Pit, at Old Hill.

In the present note I propose to indicate briefly some of the species represented, which I hope on a future occasion to describe more fully. They are very well preserved, as a rule.

The Equisetalean remains are not very numerous, and of these the specimens of the external surface of *Calamites ramosus*, Art., are the most interesting. *Annularia sphenophylloides* (Zenker) and *Calamocladus equisetiformis* (Schl.) also occur. The Sphenophyllales are represented by *Sphenophyllum cuneifolium* var. *saxifragæfolium* (Sternb.). The fern-like plants include a *Renaultia*, probably *R. Footneri* (Marrat), *Neuropteris flexuosa*, Brongn., and *N. tenuifolia* (Schl.). The Pecopterid types are varied, good specimens of *Pecopteris oreopteridia* (Schl.), as well as *P. Miltoni* (Art.) and *P.* (*Dactylotheca*) *plumosa* (Art.), occurring. A *Rhabdocarpus*, which may be compared with *R. sulcatus* (Presl), is also present.

The Lycopods are represented by *Sigillaria principis*, Weiss, *Lepidophloios acerosus* (L. & H.), and *Lepidostrobus variabilis*, L. & H. The most interesting fossil, however, is what I take to be a small specimen of the cone of *Sigillariostrobus nobilis*, Zeiller, which is the first record of this interesting species from Britain. I have also, curiously enough, obtained several undoubted examples of the same plant from the Wyre Forest Coal-field recently, and these I hope to describe before very long.

The known flora of the Old Hill Marls is too small at present to indicate the horizon of these beds beyond doubt. While many of the above species are most abundant in the Middle Coal-measures, the presence of *Pecopteris oreopteridia* (Schl.) and *Neuropteris flexuosa*, Brongn., species which have not been recorded below the Transition Series, indicate that the later is the probable horizon. The Old Hill Marls probably occupy a low position in the Transition Coal-measures. The known flora of this horizon in South Staffordshire at present consists of eight species, recorded by Dr. Kidston[1] from the Hamstead boring between 1,236 and 1,320 feet, and of these only the composite *Lepidostrobus variabilis*, L. & H., is also found in the Old Hill Marls.

REVIEWS.

I.—The Mesozoic Flora of Graham Land. By T. G. Halle. Wissenschaftliche Ergebnisse der Schwedischen Südpolar-Expedition, 1901–3. Bd. iii, Lieferung 14. Stockholm, 1913. Price 16*s*.

THE evidence that the existence of genial climates at the Poles has been the rule rather than the exception in the past is one of the most fascinating and noteworthy results of the study of fossil plants. The present memoir, none the less welcome because it appears in excellent English, is the most important contribution

[1] Kidston, Trans. Roy. Soc. Edinb., vol. xxxv, pt. vi, p. 319, 188 ; see als Quart. Journ. Geol. Soc., vol. lxi, p. 313, 1905.

to our knowledge of Antarctic fossil floras that has yet been published. It is true that Hope Bay, Graham Land (lat. 63° 15′ S.), lies without the Antarctic circle, but, as the author justly points out, the present climate of this region is purely Antarctic and its known flora includes only two species of the higher plants.

It is very remarkable to find that of the specimens from Graham Land, collected by members of the Swedish South Polar Expedition (which are not only far more numerous but much better preserved than those obtained in the Antarctic region either before or since), not a few are the same species as those with which we have long been familiar in the Lower Oolites of the Yorkshire coast. No less than nine of the species, including *Todites Williamsoni* (Brongn.), *Cladophlebis denticulata* (Brongn.), and *Coniopteris hymenophylloides* (Brongn.), are British plants, and a very large proportion of the genera are also found in England. Surely current opinion with regard to the worldwide distribution of Mesophytic vegetation could receive no more striking confirmation than is to be found in Dr. Halle's memoir.

The author distinguishes sixty-one Jurassic types either generically or specifically, and full and clear descriptions are given of each. Of these, twenty-one are new species, and two (*Elatocladus* and *Schizolepidella*) are new genera. The systematic portion of the work is followed by a discussion, at considerable length, on the known geographic distribution of the plants and the age of the beds, which are regarded as Middle Jurassic.

Dr. Halle may be congratulated on the results of his labours, and our thanks are due to him for the care and research which he has obviously bestowed on the preparation of this memoir. It is no doubt true that the study of fossil plants demands, perhaps more than any other subject, an accurately balanced judgment. Dr. Halle has shown, by the way he meets the difficulties presented by this material, that he is possessed of such judgment in a high degree. Many of the suggestions which he makes with regard to difficulties arising from homoplasy and synonymy are worthy of careful attention at the hands of all those who are working in the same field. We may also congratulate Professor Nathorst on the achievement of his pupil, whom he has obviously inspired with something of his own enthusiasm, care, and discrimination.

In conclusion, a word of praise may be added with regard to the clearness and general excellence of the plates (eight double and one single) which accompany and illustrate the memoir.

E. A. N. A.

II.—Geological Survey Memoir.

The Geology of the Country around Ivybridge and Modbury. By W. A. E. Ussher, F.G.S., with chapter on Altered Rocks by G. Barrow, F.G.S. 8vo; pp. vi, 137, with 6 plates and 26 text-illustrations. Printed for His Majesty's Stationery Office, 1912. Price 3*s*.

THIS is an explanation of the colour-printed Geological Survey map, Sheet 349. It takes in the eastern part of Plymouth, and adjoins Sheet 348, which was described by Mr. Ussher in "The

Geology of the Country around Plymouth and Liskeard" in 1907. The series of formations, stratified and igneous, in the two areas are for the most part the same, but there are certain local differences, and some modifications appear in the tabulation of them in the two memoirs.

The story of successive attempts to unravel the sequence in the South Devon rocks is well told in the Introduction, and it is noteworthy that the founders of the Devonian system had failed to determine the true sequence in the subdivisions which they recognized near Plymouth. Although the Rev. Richard Hennah is only mentioned in the Bibliography, a brief record of his local researches was given in the Plymouth memoir (p. 2), as "he was the first to point out the presence of organic remains" in the Plymouth limestone. It may be mentioned that he was Chaplain to the Garrison of Plymouth from 1804 until his death in 1846, and that the loan of his collections of fossils to Sedgwick, Murchison, and Lonsdale "afforded one of the principal sources for determining the relative geological age of the Devonian limestones".[1]

According to Mr. Ussher, the work of Jukes in 1867–8 "is of great stratigraphical value", and "he supplied an entirely new and correct rendering of the stratigraphy of the coast-section south of Plymouth". Subsequent observers, notably Holl and Champernowne, added much to the knowledge of the strata, but did not succeed in determining the true structural arrangement.

No one has laboured so long, so earnestly, and so laboriously at the interpretation of this and adjacent areas as the author of the present memoir, nor has anyone more fully realized the difficulties that are encountered. While carrying out the detailed survey on the 6-inch maps during the years 1892–7 he blocked out the main subdivisions in the strata, determined their sequence, and the equivalent rocks in adjacent areas; but, while surmounting so many of the graver difficulties, he was obliged in some tracts to leave with doubt the precise grouping of the strata. In particular he mentions the uncertainty of the boundary between Middle and Upper Devonian in the slate areas, as no fossils distinctive of the lowest beds of the Upper Devonian have been found. Moreover, the higher beds of the Plymouth limestone include portions of Upper Devonian, the zone of *Rhynchonella* (*Wilsonia*) *cuboides*, as in other areas of South Devon, and no definite plane of demarcation can be fixed between the divisions. Again, in the Lower Devonian the lines drawn between the subdivisions on the map are stated to be often uncertain. The author, however, is in his element when recording in detail the results of his observations in the field and the perplexities with which he had to deal. To anyone following in his footsteps the particulars will be of great service, but they are given at the expense in most cases of more readable, if brief, accounts of the leading lithological and palæontological features of each subdivision. Now that the area around Plymouth has been completed, it may be that the authorities will issue a special colour-printed map of Plymouth, like that of Nottingham and other places, accompanied by a memoir; and these

[1] Obituary of Hennah, by L. Horner, in Address to Geol. Soc., 1847.

would be of service to those who want to gain readily a general knowledge of the geology. It is a curious fact that, despite the detail concerning the rocks, no particulars are given in the text of the fossils determined by Dr. Kayser and Dr. Henry Woodward, as acknowledged in the Director's preface.

The contemporaneous igneous rocks include sheared lavas and tuff in the Lower Devonian, schalsteins and diabases in the Middle Devonian, and vesicular lavas and tuffs of the spilite (pillow-lava) type, also diabases, in the Upper Devonian. The intrusive rocks include a large tract of granite forming the southern part of Dartmoor with the Lee Moor china-clay works; also felsite, rhyolite, granophyre, and some basic rocks. Considerable interest attaches to the metamorphic aureole which borders the granite, the altered rocks being described by Mr. George Barrow. Certain banded siliceous and slaty rocks, which appear originally to have been carbonaceous shales and grits, are grouped by Mr. Ussher with the Culm-measures. Less certainty arises with the grouping of tracts of calc-flinta, which might be Devonian or Carboniferous. These hard flinty rocks, according to Mr. Barrow, have resulted from the alteration of calcareous sediments by pneumatolytic action, and there have been developed in them such minerals as axinite, garnet, datolite, etc. Dr. Teall has contributed some notes on the subject (not, however, indicated in the text). Allusion is made to the possible occurrence of a 'New Red Sandstone' deposit, which was originally noted by Sedgwick and Murchison, but is now so much obscured by rainwash and talus that no confirmation of the occurrence can be given. Some relics of Tertiary, possibly Eocene, strata are described; then follow short accounts of the cavern deposits, head, river gravels, rock valleys and deposits below high-water mark, submerged forests and peat. In the chapter on Economics the subjects include water supply, metalliferous mines (with notes by Mr. D. A. MacAlister), china clay, building-stone, marble, road-stone, slate, lime, peat, and soils.

The plates are good, notably that of an elvan in Upper Devonian slate at the Cann Quarry; and, needless to say, the colour-printed map Sheet 349 (price 1*s.* 6*d.*) is excellent, and well shows the great progress made by the Geological Survey, and by Mr. Ussher in particular, in elucidating the structure of South Devon.

III.—A Descriptive Catalogue of the Marine Reptilia of the Oxford Clay, based on the Leeds Collection in the British Museum (Natural History), London. Part II. By Charles William Andrews, D.Sc., F.R.S. 4to; pp. i–xxiv and 1–206 (including index), with 73 text-figures and 13 plates by Miss G. M. Woodward, and collotype frontispiece. Printed by order of the Trustees of the British Museum by Taylor & Francis, London, 1913. Price 25*s.*

THE appearance of the second volume of this Catalogue calls for the heartiest congratulations to all those responsible for the production of this highly valuable work. It must certainly be reckoned among the most important works of reference that have emanated from

the Natural History Department of the British Museum. Its execution could not have been entrusted to more capable hands than those of Dr. Charles W. Andrews, who deserves the warmest praise for the high degree of skill and scientific learning which he has applied to the completion of a task requiring close and protracted study to bring it to so successful a termination. The publication of these two volumes is the more welcome, as for the first time it allows us to obtain an adequate idea of the enormous mass of extremely valuable material contained in the Leeds Collection. It must be a matter of no little satisfaction to Mr. Alfred N. Leeds to see brought together in these volumes the valuable results thus obtained for palæontological research by nearly fifty years of careful excavation and observation, coupled with patient labour in restoring the specimens from innumerable fragments.

The present volume is devoted to a second branch of the Plesiosaurs, namely the Pliosauridæ, and to the Crocodilia, which are particularly richly represented in this collection. Following the method adopted in the first volume, the author has initiated the description of the various species belonging to these classes by an admirable Introduction, in which he sets forth the main results of comparative research into the relations of the Oxford Clay Reptilia with those of earlier and later deposits. In the evolutionary history of the Crocodilia nothing new has been ascertained, nor has much new light been thrown on the problems surrounding the Sauropterygia. But Dr. Andrews is led apparently by his studies for the purposes of the compilation of this Catalogue to lay aside an earlier opinion that the latter group is allied to the Rhynchocephalians, and now declares himself an adherent of the view expressed by A. S. Woodward and Williston that it is to the Theriodontia that we must look for their origin. On the other hand, Dr. Andrews is unable to assent to Williston's attempt to define the Pliosauridæ, and notes certain differences in the relations of the sphenoids to the pterygoids as compared with the Cretaceous *Trinacromerum*, although in the relationships of the frontals and parietals he finds the Pliosaurs to be nearer akin to the North American than to the European Plesiosaurs. This latter important modification of his earlier description of the skull of the principal specimen of *Pliosaurus ferox* has emerged in the course of examination of a large number of examples of Pliosaur skulls, particularly of *Peloneustes*. In addition to the new species *Simolestis vorax*, other recent acquisitions by Mr. Leeds have included a large Pliosaur, temporarily referred to *Peloneustes Evansi*, though it is found to differ so considerably from the genus, which was created by Lydekker for the reception of *Pliosaurus philarchus*, that Dr. Andrews hints at the necessity of its ultimate assignment to an entirely new genus. Highly interesting is the occurrence in this series of some of the bones of a young animal. It is to be regretted that no figure was included, as it would have given a far clearer idea of the extraordinary changes which took place in such bones as are known before the fully adult state was reached. Although the ribs are well described, no account even is given of the ischium, which by reason of its extraordinary massiveness, with additional thickness at

the centre, is the exact inverse of what is found in full-grown animals. One may wonder whether the bad preservation of Pliosaurian dorsal vertebræ from the Oxford Clay may not be due in a large measure to the retention through life of the spongy texture so noticeable in the bones of the young animal. That some peculiarity pertained to this genus seems to follow from the fact that, though distortion from pressure is not uncommon in other classes of Reptilia from this deposit, when it does occur it is not as a rule confined to the dorsal region, whereas in the Pliosaurs the dorsal vertebræ are practically never found in any other condition.

Dr. Andrews had already published an anticipatory account of the various species which he has distinguished among the large series of Teleosaurian Crocodilia, but in this, the final presentation of the results of his researches, he not only includes a new species in *Steneosaurus hulkei*, but finds himself compelled to refer to an entirely new genus, *Mycterosuchus*, the specimens formerly described as *Steneosaurus nasutus*, possessing as it does marked differences in the structure of some of the vertebræ, the form of the skull and the humerus, and the relative size of the fore and hind limbs. In this connexion it is now shown that in the Steneosaurs, at least, the general characteristics of particular bones in any given species are present throughout the whole skeleton; thus *St. Leedsi*, with its slim and slender skull, is associated with sharper teeth, longer and more slender vertebræ, with lighter neural spines. It should now be possible to refer almost any isolated bone to its proper species. It is interesting to note that, though the author can find among the Peterborough Steneosaurs no species exactly comparable with those from the same strata in Northern France, he fully admits in his account of *St. hulkei* (of which an illustration would have been welcome) the possibility that what are regarded in this Catalogue as specific features may be in part nothing more than age-characters. This statement is important, and is only here rendered possible by the extensive series of skulls, all derived from the same area. On the other hand, it has to be remembered that the variant form of coracoid, as shown in figs. 69 and 70, is found in fully developed representatives of one and the same species.

The genus *Metriorhynchus* vies successfully with *Ophthalmosaurus* in its frequency in the Peterborough deposits, and is represented in this Catalogue by an unusually fine series of skulls, among which Dr. Andrews recognizes no less than seven species. This is the first time that any comprehensive account of this genus, as found in England, has been published, and the author is to be congratulated on the moderation which he has displayed, amid such a wealth of material to choose from, in creating new species. Here, again, it is probable that age-characters may be responsible for many of the variations which would undoubtedly have aroused some palæontologists to indulge in a perfect orgy of terminological invention. With the distinctions drawn in this Catalogue there can be no complaint on that score. In this genus we come more into touch with the Normandy crocodiles, no less than three species named by French scientists being identified in England also. Three species,

M. læve, *M. Leedsi*, and *M. cultridens*, are, however, entirely new and have not been previously described. The seventh, *M. durobrivense*, was known as long ago as 1890, but was then called *Suchodus* by Lydekker. It has now, and without a doubt correctly, been assigned to *Metriorhynchus*. An excellent and most useful figure (No. 73) enables the principal points of difference in the skulls of these seven spēcies to be obtained at a glance, though it is doubtful whether both this figure and plate xi are not liable to convey a somewhat false impression as to the nature of the sculpture of the frontal bones of *M. cultridens*. The species is based on R. 3804, an example in which these bones, when found, were covered by hard concretionary matrix, such as is still visible on the palatal surface, and the process of freeing the bones from this matrix has seldom been executed without the removal of parts of the surface of the actual bone along with it. Such parts, however, as are still uninjured suggest that the sculpture must have closely resembled that of *M. brachyrhynchus*. On the other hand, a view of the uncrushed posterior aspect of this skull would probably have given a better idea of the form of this region than that of *M. durobrivense* on plate xiii, which has admittedly suffered some compression.

One result of Dr. Andrews' examination of this genus is that he entirely discards as an unreliable criterion the measurement across the prefrontals, hitherto employed as one of the standard dimensions for recognizing the various species.

No mention is made of ventral ribs in connexion with *Metriorhynchus*. These, though scarce, are not unknown, but perhaps are not contained in the Museum collections. It would have been interesting to know whether Dr. Andrews would have regarded them as another characteristic acquired by the Metriorhynchidæ, in accordance with their more aquatic habits, which led them to discard the dermal armour with which the amphibious Teleosaurs were protected.

The comparison of the Metriorhynchidæ with the slightly later Geosauridæ is interesting and useful, but we hardly think that it called for the insertion in a Catalogue of English Oxford Clay Marine Reptilia of a whole-page illustration of a specimen of *Geosaurus*, a genus which must already be familiar to all students of vertebrate palæontology from Continental works. Skeletons of Geosauridæ, in the condition in which the Metriorhynchidæ have been recovered from the Oxford Clay, are unknown on the Continent, and even if no skeleton of *Metriorhynchus* was considered worthy of the honourable position of the frontispiece, surely some other, for example the typically Oxfordian *Peloneustes*, might well have had this plate allotted to it. It may argue for a greater degree of cosmopolitanism on the part of English scientists, but it is well-nigh inconceivable that any continental scientific institution would have figured in a similar position a skeleton from England, however much they might have been alive to its importance for comparative study. In any case, in the present instance the result can hardly be said to justify the decision which prompted its insertion. Apart from this the illustrations leave little to be desired. They are executed with all her

accustomed skill by Miss Gertrude M. Woodward, and form a great enhancement to this valuable work. The admirable plates, thirteen in number as compared with ten in the first volume, are mainly devoted to skulls of which more specimens are forthcoming than in the sections dealt with in the companion volume, rather, indeed, to the exclusion of other parts of the skeleton. The reduction in size of many of the text-figures is a great improvement to their appearance, while detracting nothing from their value.

May we hope that the success which has attended the publication of this Catalogue of the first rank may induce the Trustees to sanction the production of a companion volume on a similar scale which shall bring together the remainder of the remarkable treasures of the Leeds Collection, namely, the Fishes and the Dinosaurs, with, perhaps, the tail of *Leedsia problematica* as a frontispiece?

IV.—Geology of the Federated Malay States.

The Geology and Mining Industry of the Kinta District, Perak, Federated Malay States. With a geological sketch-map. By J. B. Scrivenor, M.A., F.G.S. 8vo; pp. 91, with 11 text-illustrations and 20 plates. Kuala Lumpur, 1913. Price 3 dollars (about 5*s.* 3*d.*).[1]

THIS memoir is descriptive of a tract in the north-western part of the States, the Kinta River, which traverses the area, being one of the chief tributaries of the Perak River. Granite mountains, the Main Range and the Kledang Range, border the country on the east and north-west respectively, while the intervening valley region is occupied firstly by limestone, containing pipes and fissures with detrital tin-ore, and then by coverings of Gondwana Beds and superficial deposits. It has not been deemed advisable to colour on the map the Alluvial beds, as they somewhat obscure the metalliferous strata, and the object is essentially a practical one. In old days the recent Alluvium was an important source of tin-ore, but this is no longer the case.

The limestone forms a rugged floor to the valley, but it is difficult in many places near the river to determine the limits of the overlying clayey and sandy strata of the Gondwana formation. In several localities the limestone rises in precipitous hills due primarily to displacement, the cliffs in fact being fault-faces with the basement Gondwana rocks (Gopeng Beds) faulted down against them.

There is evidence that the limestone and Gondwana rocks were covered at one time by "a huge pile of younger rocks", and that all were crushed and folded, and bent as a whole into a low anticline. These disturbances were caused by the intrusion of the granite, which was probably separated at some depth from the limestone by "a considerable thickness of still older rocks" that were broken up "and perhaps completely dissolved in the granite magma". The granite is stanniferous, and prior to its complete solidification "spurts of vapour and molten rock, carrying tin amongst other things"

[1] On sale at the Malay States Agency, 88 Cannon Street, London, E.C.

penetrated the bordering rocks. Subsequent denudation has led to the production of the present physical features.

The limestone is characterized by its crystalline structure, and although sometimes banded with black layers it is usually a beautiful white saccharoidal marble. The prominent limestone hills before mentioned are regarded by the author as "large blocks of the crust that sank on to the granite magma, relatively less than the surrounding rocks when the Main Range anticline broke up". No palæontological evidence has been obtained to prove the age of the limestone in the Kinta valley, but in Pahang the same limestone, less altered, contains Carboniferous fossils. It is the oldest known rock in situ in the Federated Malay States, there being no justification for the statements that have been published concerning the presence of Archæan rocks.

In describing the Gondwana rocks the author discusses the evidence which leads him to regard the basal clays with boulders as of glacial origin. The clays all contain a certain amount of sand which yields tin-ore and other minerals. In the western part of the area the boulders are mostly tourmaline-corundum rocks; in the eastern part (Gopeng, etc.) pure corundum boulders occur, as well as a greater variety of other rocks. Referring to the Gopeng clays the author considers that their constitution and the field evidence clearly point to the tin-ore having been derived, with the other minerals, or the bulk of them, from some mass of tin-bearing granite and associated altered rocks, distinct from and older than the Main Range (Mesozoic) granite. At Tekka there are sections showing that the clays are altered by this granite and invaded by veins of it. It is noteworthy, however, that no clear evidence has been seen of striations or of polished rock-surfaces. The overlying Gondwana rocks comprise chiefly phyllites and quartzites, with also mica-schists, tourmaline-schists, and shales. These newer rocks contain cassiterite, which the author believes to be an original detrital constituent.

The latest accumulations are those of the lignite and Alluvium; indeed, the lignites and associated sands appear to form part of the Alluvial deposits, and their thickness in some places "may indicate a long period of deposition in pools or lakes over an area where rapid solution of the limestone bed-rock below led to a steady subsidence of the surface of the ground".

The concluding portions of the memoir contain particulars of the principal tin-mines and notes on other minerals found in the district. The numerous plates illustrate by excellent photographs some of the physical features of the country, faulted tracts, rock-formations, boulders, mine-works, ore-deposits, and micro-sections of rocks.

V.—United States Geological Survey.

BULLETIN 494 (1912) is on "The New Madrid Earthquake", by Mr. Myron L. Fuller. This somewhat ancient earthquake, named after New Madrid in Missouri, comprised a succession of shocks, beginning on December 16, 1811, and lasting more than a year. At that time the region was almost devoid of settlers, and the published accounts were few; nevertheless, the results of the

disturbance caused it to be regarded as one of the great earthquakes of the world, and according to Mr. Fuller it may be taken as a type, exhibiting in unusual detail the geologic effects of great earth-movements upon unconsolidated deposits. The area affected was in the Central Mississippi Valley, including South-Eastern Missouri, North-Eastern Arkansas, and Western Kentucky and Tennessee. After gathering the information previously published, and calling special attention to the graphic account given by Lyell, the author describes many features still well preserved, among them fissures and faults, the former in many cases being infilled with intruded sand (sand-dikes).[1] Other features comprise sunk lands, among which are sand sloughs or broad and shallow troughs with ridges covered by extruded sand (sand-blows); also certain river-swamps, and tracts with lakes. Thus Reelfoot Lake in Tennessee, which is 8 or 10 miles in length and 2 or 3 in breadth, indicates a submergence of from 5 to about 20 feet, and rising from its waters there are still numerous shattered stumps of trees that flourished prior to the catastrophe. The earthquake is attributed to earth-movements "associated either with the processes of folding or warping, or incident to a depression and deepening of the basin". The subject is well illustrated with maps, diagrams, and pictorial views.

Bulletin 499 (1912) contains an account of "Coal near the Black Hills" on the borders of Wyoming and South Dakota, by Mr. R. W. Stone. Cambria is the only place where good workable coal has been found over a considerable area. It occurs in the Lakota Sandstone (Cretaceous), and it is remarkable that the sedimentary strata and the coal itself contain both gold and silver. In the coal the average value per ton of the gold is $2·46, and of the silver $·28. The author remarks that "the most plausible explanation seems to be that the sands which submerged the swamp and now form the roof of the coal-bed were derived in part from old gold-bearing alluvium. . . . Currents which transported the sand and the grit which occur in some places a few feet above the coal certainly were strong enough to transport fine gold. While the sand was being deposited the gold may have worked down into the underlying bog and is now found in the coal".

Bulletin 500 (1912) is on the "Geology and Coal-fields of the Lower Matanuska Valley, Alaska", by Messrs. G. C. Martin and F. J. Katz. The formations include (1) various schistose rocks, classed as Palæozoic, (2) greywackes, slates, and igneous rocks, classed as Early Mesozoic or older, (3) Jurassic, (4) Cretaceous, (5) Tertiary, and (6) Quaternary. The coal-bearing strata belong to the Chickaloon formation of the Eocene, which covers the greater part of the valley of the Chickaloon river, south of Castle Mountain. In thickness the formation appears to be at least 2,000 feet, and it consists of shales and sandstones with ironstone nodules and seams of coal, also many plant-remains, chiefly leaves. Much of the coal is of high-grade bituminous character. Seams occur in thickness up to about 14 feet, but these are often shaly, and the thickness is usually much less. The outcrops occur generally at steep angles.

[1] See also article by Dr. A. P. Pavlow, GEOL. MAG., 1896, p. 49.

The general geology presents many points of interest and is illustrated by coloured geological maps and pictorial views; there is also a map of Central Alaska, showing the position of the coal-fields.

VI.—Underground Water Resources of Iowa.

THE twenty-first volume of the Iowa Geological Survey contains the Annual Reports for 1910 and 1911, with statistics of the Mineral Production of the State for 1909 and 1910; but it is occupied mainly by a connected series of reports on the Underground Water Resources. The result, a huge quarto volume of xvi + 1214 pages, has been issued under the direction of Mr. George F. Kay, the State Geologist. The investigation of the water-supply was initiated by the late Samuel Calvin, and since 1903 it has been carried on in co-operation with the United States Geological Survey.

The artesian waters have been studied in particular by Mr. W. H. Norton (geologist for underground waters); the waters of the Drift and Country Rock, or the ground waters, are dealt with by Messrs. Howard E. Simpson and O. E. Meinzer, and their chemical and industrial qualities are discussed by Professor W. S. Hendrixson. Here it may be mentioned that the term 'country rock' is applied to "the rock which outcrops at the surface or immediately underlies the drift"; while the term 'aquifers' is given to the 'water-beds', or, as we should call them, the water-bearing strata.

The artesian aquifers are mostly deep-seated and of early Palæozoic age, but the strata naturally approach and come to the surface in places, where they might be included in the country rocks.

Iowa State is divided into ninety-nine counties, and fortunately the Geological Survey, having very nearly completed the field-work of the entire area, had also accumulated much information relating to the geologic conditions which control the ground water. Further particulars, as full as possible, have now been gathered from the officials of each town and from well-drillers in connexion with the underground water-supply. It is justly remarked that with regard to the artesian waters "there is needed the skillful interpretation of data collected from a wide area, a knowledge of the geological structure and acquaintance with the distribution and movements of deep waters", as "the local well driller cannot be expected to know either the quantity or quality of artesian waters or the depth at which they can be reached".

Many useful hints are given on the collection and preservation of samples from borings, on the errors that may arise in the determination of the nature and thickness of the rocks by means of drillings and the contents of slush-buckets, the difficulty and rarity of getting precise palæontological evidence, and of the local experience necessary in determining the age of formations by lithological evidence.

These and other matters are discussed by Mr. Norton in an Introduction to the general account of the Underground Water Resources. The Topography and Climate are dealt with by Mr. Simpson; the Geology by Messrs. Norton and Simpson, who give a useful table of

formations, with their lithological characters. Particulars are given of the geologic occurrence of the underground waters, and of the effects due to the inclination and undulations in the strata of the artesian system, chiefly thick sandstones in the Cambrian and Ordovician. The Cretaceous System also contains much artesian water in the Dakota Sandstone, while the Pleistocene or Drift sands and gravels "yield supplies to innumerable shallow wells in nearly all sections and are the most important source of water in the State". The term artesian is rightly used to include not only the water of flowing wells, but also well-waters that rise to a considerable height within the tube under hydrostatic pressure.

After the general remarks on the Underground Waters, the subject is treated under eight districts, each including a number of counties, the object being to furnish to each community, so far as possible, information on the artesian water, whether it can be found at certain localities, at what depth it may be reached, through what formations the drill must pass, what mineral compounds (healthful or harmful) the water is likely to contain, how high it will rise, how large will be its discharge, with remarks on its probable permanence. Geologists in this country are chary in giving forecasts of the quantity of water likely to be obtained from a boring, and it is usually thought sufficient to give an estimate of the probable depth at which water would be reached. Indeed, in the present work Mr. Norton advises that "contracts for artesian wells should make provision for drilling at specified rates for several hundred feet beyond the supposedly necessary depth". At the same time, many official predictions have proved accurate enough for practical purposes, as in cases where the estimate was 700 to 750 feet and water was found at 715, or the estimate was 800 and water occurred at 780, or the estimate was 1,300 to 1,500 and water was found at 1,408 feet.

One of the more remarkable water-bearing formations in Iowa is the St. Peter Sandstone of the Ordovician, and it is the highest aquifer of the Palæozoic Series. A map of the State has therefore been given to show by contours the elevation above sea-level of the top of the sandstone, with contours also of the artesian head of water. Along its outcrops it is a massive homogeneous bed of 'millet-seed' sand. Below ground it is said always to yield some water, and in many places an abundant supply. There is also a Drift map of Iowa, showing the coverings of Kansan, Illinoian, Iowan, and Wisconsin Drifts, also the driftless area. In fact, no pains have been spared to make the volume an eminently practical and reliable work of reference.

VII.—Did Coral-reefs exist in the Palæozoic?

Les récifs coralliens existent-ils dans le paléozoique? By N. Yakowlew. Bull. du com. géolog., tome xxx, No. 201. pp. 847–57. St. Pétersbourg, 1911.

In this contribution the author states the views he has arrived at on this subject after more than ten years of geological research among the Palæozoic rocks of the Ural, Timan, Donetz Basin, and

the Courlande. In the reefs found in the Palæozoic rocks, as exemplified by the Carboniferous of Belgium, Devonian of Germany and Poland, and the Silurian of Gotland, the *Zoantharia* (*Rugosa* of the Palæozoic rocks) play a less important part than they do at the present day. The main constituents of these Palæozoic reefs are *Stromatoporoidea*, and next to them in importance come the *Tabulata*, and lastly the *Rugosa*. Reefs which are entirely composed of rugose corals are unknown.

M. Yakowlew has discovered reefs formed exclusively of *Stromatoporoidea* in the Devonian of the Courlande, and reefs made up for the most part of *Stromatoporoidea* in the Carboniferous of the Timan. The reefs found in the Middle Devonian of Poland are formed of *Stromatoporoidea*, together with some *Rugosa* and *Tabulata*, while less extensive coral masses composed essentially of *Tabulata* are found in the Upper Devonian.

An examination of the views of Grabau and Vaughan on the coral reefs of the Palæozoic rocks, chiefly American, leads M. Yakowlew to the opinion that the conclusions of these authorities on the subject of the analogy of the coral reefs of the Palæozoic and posterior epochs are not confirmed by the facts that they quote. He does not see any analogy between the 'knoll-reefs' of Grabau and of Tidemann [Tiddeman] and the reefs of the present day. The view expressed by Bonney that conditions other than those of the present time might have influenced the formation of reefs in the Palæozoic period appears to him to be more acceptable.

I. T.

VIII.—A Monograph of the Cretaceous Lamellibranchia of England. By Henry Woods. Palæontographical Society, 1899–1913. 14 parts, making 2 vols. 4to; pp. i–xliii, 1–232, 42 plates; pp. 1–473, 62 plates.

THE completion of so monumental a work demands more than a passing notice. Mr. Woods has given us a reference book of the utmost value for the identification of our Cretaceous fossils. The valuable bibliography and the excellent and full synonymies must lighten the labours of all future workers and give a final opinion on all questions of nomenclature. Throughout the whole work there is evidence of the utmost care, although in the last part signs are not wanting of weariness in the very brief account of the Radiolitidæ and the paucity of the "Additions". There are still a number of new things in public and private hands awaiting description, and perhaps Mr. Woods may be induced to return to them after a brief rest. The Gasteropoda and the Cephalopoda now want tackling to round off the Molluscan fauna of the English Cretaceous.

The illustrations have maintained a high standard throughout the work, and in the two groups of the Inocerami and the Ostræidæ the Council of the Palæontographical Society has with wise generosity allowed Mr. Woods remarkable freedom. We therefore see not only one specimen of each species properly figured but whole series of each species displayed, showing all the varieties of shape that the species exhibits. It is therefore now possible to determine nearly all the

puzzling anomalies of a species of these genera with an ease and certainty hitherto quite impossible.

One criticism Mr. Woods must allow us to make, if only for the guidance of the editor; that is, that in these days of accurate collecting, it is essential that the name of the collector should be inserted after the name of the locality, whenever known. It would add very greatly to the value of such a monograph as this to know that Dr. Blackmore, for instance, was responsible for the statement that *Ostrea semiplana* occurred in the zone of *Act. quadratus* of East Harnham. In the present case such proof is not forthcoming. We congratulate and thank Mr. Woods for the valuable work he has completed.

IX.—Brief Notices.

1. Southern Rhodesia.—The Report of the Director of the Geological Survey, Mr. H. B. Maufe, for 1911 (1912), records the wide distribution of tin-bearing rocks; notes that the majority of the productive gold-mines do not lie in the schist-belt as is generally thought, but in a peculiar granitic mass, named the Mont d'Or granite; and refers to the important chrome iron-ore deposits which occur in a mass of serpentine and talc-schist.

There are special reports (1) on the geology of the country around Selukwe, by Messrs. A. E. V. Zealley & B. Lightfoot, with a general introduction by the Director; (2) on the geology of the Victoria Tin-field, by the Director; (3) on the asbestos quarries, Victoria District, by the Director; (4) on the claims of the Great Sabi Coal Syndicate, Victoria District, by Mr. Lightfoot; (5) on claims pegged for aluminium near Selukwe, by Mr. Zealley; and (6) on a traverse from Gwelo to Bulawayo, by Mr. Zealley. With regard to the asbestos Mr. Maufe observes that it consists of the fibrous form of serpentine, known as 'chrysotile asbestos'.

2. Meteoric Iron from Perryville, Missouri.—The block, which weighed about 17½ kilograms, was found in an open field, about three-fourths buried in the soil. It is described by Mr. G. P. Merrill (Proc. U. S. Nat. Museum, xliii, December, 1912), who records, among ordinary constituents, traces of iridium, palladium, platinum, and ruthenium. The author states that so far as he knows this is the first authentic instance of the occurrence of ruthenium in a meteoric iron.

3. Underground Waters of Poitou.—In "Spelunca" (Bulletin et Mémoires de la Société de Spéléologie, ix, September, 1912), Professor Jules Welsch records the results of his detailed studies of the "Hydrologie souterraine du Poitou calcaire", in the Departments of Vienne, Deux Sevres, and Vendée, which together coincide closely with the old province of Poitou. After describing the general physical features and geological structure of the region, he deals in particular with the areas of Jurassic limestones from the Lias to the Corallian, etc. (Rauracien-Séquanien). Water-bearing horizons occur throughout the series, but they are most copious in the Bajocian and Bathonian. The sources of the waters, their circulation as affected by dislocations, folds, faults and fissures, the caverns, swallow-holes,

underground channels and springs, are very fully described, with remarks on sources of contamination.

4. Iridosmine in the Transvaal.—This alloy was discovered several years ago by Mr. A. F. Crosse in the Rand bankets. Its occurrence in the New Rietfontein Mines is recorded by Mr. C. Baring Horwood (Trans. Geol. Soc. South Africa, xv, 1912), and he describes it as an intimate mixture of iridium and osmium, generally with ruthenium, and sometimes with a little platinum, chromium, gold, and palladium. The metals in the banket reefs, in his opinion, are of secondary origin, having originated as segregations formed by magmatic concentration in the basic eruptive rocks of the mines, and from these dykes they were extracted by the action of superheated gases. Later still, hydrothermal action probably played an important part in concentrating them in the banket reefs.

REPORTS AND PROCEEDINGS.

I.—The Royal Society.

March 6, 1913.—Sir Alfred Kempe, Vice-President and Treasurer, in the Chair.

The following communications were read:—

1. "The Evolution of the Cretaceous Asteroidea." By W. K. Spencer. Communicated by Dr. A. S. Woodward, F.R.S.

An endeavour is made to trace the evolution of the Starfish through the whole of the Cretaceous deposits. At the first sight the material appeared to be unpromising, for complete or even fragmentary specimens are rare. It has been found possible, however, to use the isolated marginal plates which are found fairly commonly on weathered chalk surfaces. It is shown that these marginal plates have a shape and ornament characteristic of each distinct species. The species may be arranged in lineages, and the examination of large collections made by English and Continental workers make it feasible to trace the life-history of most of the lineages. Each lineage shows definite stages of advance (elaboration) followed by stages of regression. Occasionally a lineage will re-elaborate after passing through the regression stages ('rhythmic' or 'periodic' variation). Elaboration and regression are closely parallel in the lineages. They consist of changes in the size, the height, and the character of the ornament of the plates.

Variation as shown, both through measurements and by general examination, is, in general, of the 'continuous' type. Discontinuous variations ('saltations') are known, but they appear to be relatively of little importance. The measurements also show (1) that there is close connexion between the general vitality of the race, as shown by its range of variability, and the rhythmic phases alluded to above; (2) that the rate of elaboration is affected by environment.

It has not been found possible to show that selection plays any predominant part in the evolution of the lineages, and it is suggested that inborn racial character is the predominant influence in causing modification.

The bearing of the research upon various problems in stratigraphy is considered, especially in relation to recent research by Brydone, Niellsen, Ravn, and Rowe.

2. "A Preliminary Note on the Fossil Plants of the Mount Potts Beds, New Zealand, collected by Mr. D. G. Lillie, Biologist to Captain Scott's Antarctic Expedition in the *Terra Nova* in 1911." By E. A. Newell Arber, Sc.D. Communicated by Professor T. McK. Hughes, F.R.S.

The communication briefly discusses the first results which have reached this country of the late Captain Scott's second Antarctic Expedition. In the winter months of the last two years the *Terra Nova* has been at work in New Zealand waters. During these periods Mr. D. G. Lillie, one of the biologists of the Expedition who has been attached throughout to the *Terra Nova*, has been endeavouring to clear up on the evidence of the fossil floras some of the many points which remain unsolved with regard to the stratigraphical geology of New Zealand. In particular, he has made large collections from the Mount Potts Beds, in Ashburton County, Canterbury. Whether these beds contain *Glossopteris*, as asserted by Hector and others, has long been a matter of dispute, for the whole question whether New Zealand formed part of the great Southern Permo-Carboniferous Continent of 'Gondwanaland' depends entirely on the character and age of the flora of these beds.

As it proves, the flora of these beds is thoroughly Mesozoic. It is true that one of the most striking plants represented is one which very closely simulates *Glossopteris*, but the lateral nerves do not anastomose. This genus is already known from the Rhætic of Chili, and has been referred by Solms to the Palæozoic genus *Lesleya*. It is, however, here referred to a new genus *Linguifolium*, and the New Zealand species is distinguished as *L. Lillieanum*, sp. nov. The associated species include a new species of *Chiropteris*, leaves of a *Baiera*, similar to the Rhætic *Baiera paucipartita*, Nath., with fronds of *Dictyophyllum acutilobum* (Braun), *Thinnfeldia lancifolia* (Morris), and *Cladophlebis australis* (Morris). In addition, the Upper Gondwana conifer, *Palissya conferta* (Oldh.) and fronds of *Tæniopteris Daintreei*, McCoy, occur.

The flora as a whole consists chiefly of Rhætic plants, though a few Jurassic types also occur, and thus the age of the beds is either Rhætic or Lower Jurassic. The Mount Potts Beds are admittedly the oldest plant-bearing series, in a geological sense, as yet discovered in New Zealand. No Palæozoic plants are known from these islands, and there is thus no evidence that they formed part of 'Gondwanaland' in Permo-Carboniferous times.

II.—Geological Society of London.

(i) *March* 5, 1913.—Dr. A. Strahan, F.R.S., President, in the Chair.

The following communications were read :—

1. "The 'Kelloway Rock' of Scarborough." By S. S. Buckman, F.G.S.

The author has studied the types of ammonites from the Kelloway

Rock described by Leckenby, preserved in the Sedgwick Museum, Cambridge, and a series of Yorkshire Kelloway Rock ammonites from the Museum of Practical Geology, London. He has grouped these ammonites according to their different matrices, and finds that they indicate several different zones. These zones he arranges in sequence, and suggests how they may be compared with the sections of Kelloway Rock of Scarborough given by Leckenby and by Fox-Strangways. The exact order of the zones is, in one or two cases, not considered to be proved, but the paper is offered with the idea of indicating where further work is required.

An examination of the ammonite fauna of the Yorkshire zones shows that the so-called 'Kelloway Rock' of Yorkshire is in part contemporaneous with the Oxford Clay of the Midlands and the South of England, and in part contains faunal facies not represented in these areas, but peculiar to Yorkshire so far as England is concerned; they show, however, some affinity with faunal facies in Russia and in Normandy.

An examination of the list of species of ammonites recorded by Fox-Strangways from the Oxford Clay of Yorkshire shows that the Oxford Clay of Yorkshire itself is not in the main sequential to the Kelloway Rock, but is contemporaneous with it, leading to the inference that even in Yorkshire itself part of the Kelloway Rock is only a local manifestation, and that it passes laterally into Oxford Clay.

A table of zones is given, in order to illustrate the contemporaneity of the Kelloway Rock - Oxford Clay deposits of Yorkshire and the Midlands, while at the same time showing the various non-sequences in both areas.

Some critical palæontological remarks are made concerning the identification of certain species of ammonites, and a correction of nomenclature is made, with a new name for a species misidentified on account of homœomorphy. This leads to a few remarks on development and homœomorphy, wherein an important difference in the mode of development of certain Kelloway Rock - Oxford Clay genera is pointed out, and it is remarked that there are three methods of homœomorphy—(1) subparallel, the likeness of stocks passing through similar stages; (2) transversal, the likeness of stocks starting from different forms meeting at a cross-over or collision-point; and (3) cyclical, the likeness of an anagenetic to a catagenetic series.

2. "On Jurassic Ammonites from Jebel Zaghuan (Tunis)." By Leonard Frank Spath, B.Sc., F.G.S.

Jebel Zaghuan, the best-known and most conspicuous, though not the highest, mountain of the Tunisian Atlas, is built up largely of massive bluish-grey limestones of confused stratification which have been referred to the Middle Lias on the evidence of badly preserved Belemnites and *Terebratulæ*, notably '*Pygope*' *aspasia*, *Columna* sp. Middle Liassic (Domerian) ammonites are now recorded for the first time. A new classification of the Domerian genera of the family Hildoceratidæ, to which the fossils from Jebel Zaghuan belong, is proposed.

Moreover, the ammonites collected by the author afford sufficient evidence of the presence of the zone of *Reineckia anceps*, which occurs in Algeria, but had been supposed absent in Tunis together with the other beds intervening between the Middle Lias and the Corallian. The Middle Jurassic transgression must, therefore, have begun in Lower Oxfordian times, since the deposits of that age probably rest directly on the Domerian.

The upper zones of the Oxfordian, as well as the lower part of the Corallian as interpreted by Mr. Buckman—that is, the *cordatus* and pre-*cordatus* zones—seem to be absent, although there is a possibility that they have been cut out by the extensive faulting, of which the general calamitization seems to afford proof.

On the other hand, the Argovian, or zone of *Peltoceras transversarium*, is very well represented. About seventy specimens were collected at a locality called Sidi Bu Gubrín, but the list includes forms from the *transversarius* zone mixed with some from the '*acanthicus*' beds. If we call to mind the curious fact that not only in the Southern Alps but also in Sicily the Argovian is very well developed, to the exclusion of the higher beds of the Corallian, followed without any apparent break by the '*acanthicus*' beds, it appears quite probable that the two 'zones' occur here in a similar manner, and that the apparent mixture is not due to doubtful identifications of badly preserved specimens.

Most of the forms are certainly of Argovian age, and with regard to the remainder the stratigraphical value is problematical. The presence of the '*acanthicus* zone', therefore, must remain doubtful, although on the neighbouring Jebel Ben Saïdan deposits of that age occur, and indicate a third transgression in Central Tunis during Kimmeridgian times, which brought back the sea and gave rise to deposits of red ammonitic Knollenkalk exactly similar to that of the Lower Oxfordian and the Argovian.

(ii) *March* 19, 1913.—Dr. Aubrey Strahan, F.R.S., President, in the Chair.

The President announced that the Council had awarded the Proceeds of the Daniel Pidgeon Fund for the present year to Roderick Urwick Sayce, B.A., University College of Wales, Aberystwyth, who proposes to investigate the rock-succession and structure of the Ystwyth Valley and its neighbourhood.

The following communications were read:—

1. "The Geology of Northern Peru: Tertiary and Quaternary Beds." By Beeby Thompson, F.G.S., F.C.S.

This paper deals with the physiography, physical history, and geology of some 600 square miles of territory in the westernmost part of South America, between the fourth and fifth degrees of south latitude, and between the Andes and the sea.

The connexion between the surface configuration of the district and the arid nature of the climate is shown.

A description is given of the tablazos, raised beaches, quebradas, and salinas, etc.

Then follows a physical history of the region, as told by the rocks themselves, from early Eocene times to the present. A great uplift and folding of the rocks took place in late Oligocene or early Miocene times, followed by a comparatively short terrestrial epoch. A subsequent depression allowed of the deposition of Miocene and possibly later beds.

In what may be considered as recent ages the area has been spasmodically rising. It is shown that the elevation of the near Andes is a comparatively recent event.

The series of rocks exposed propably attain a thickness of 5,000 feet or more. The whole is divided into four groups of formations—Recent, Miocene, Oligocene (?), and Eocene, and each of these into sets of beds.

By far the most important of these groups of formations is the Eocene, in part corresponding to the Tejon of the Coatinga district of California. This yields abundance of fossils, and is the only series of beds that yield oil. Eight palæontological zones in this series are established. About 150 species of fossils are recorded, of which the larger proportion are probably new species.

The origin of the petroleum is traced to animal organisms.

2. "The Internal Cranial Elements and Foramina of *Dapedius granulatus*, from a specimen recently found in the Lias at Charmouth." By George Allan Frost, F.G.S.

The specimen described was found near the formation known as 'the fish-bed', in the *semicostatus* zone between Charmouth and Lyme Regis, and was embedded in an ovoid nodule of indurated Lias.

Owing to the complete envelopment of the skull and its subsequent pyritization, the bones and delicate interorbital septum are preserved in perfect condition, permitting the accurate delineation of the openings for the nerves. The bones apparently are completely ossified, and the entire build is massive, the heavy outer cartilage-bones receiving support internally from the well-developed orbitosphenoids. The supraoccipital, which alone exhibits signs of erosion, shows clearly the bony texture.

There is no foramen in the parasphenoid in front of the basipterygoid processes, as in *Lepidotus*.

The basicranial canal differs from that in *Amia calva*, in its extension to the rear of the skull, that in *Amia* ending in a cul-de-sac half-way.

The third, fourth, and fifth nerves in *Dapedius* have their most probable entry through a large median opening between the orbitosphenoids, and not as in *Amia* from the basicranial canal.

The opisthotics are stout and prominent bones, with an upward inclination corresponding to that of the parasphenoid.

The foramina for the optic and olfactory nerves are clearly shown, the latter nerve having been exposed for about two-fifths of its course across the orbit, thereby differing from *Amia* and *Lepidotus*, in both of which it is enclosed in canals.

There are two openings between each orbit and the nasal fossa.

The basioccipital exhibits a small condyle on each side, and is produced posteriorly in a process above the entrance for the notochord.

III.—Edinburgh Geological Society.

February 19, 1913.—Dr. John S. Flett in the Chair.

The following communications were read :—

1. "The Geology of Raasay." By Mr. H. B. Woodward, F.R.S. Communicated by Dr. John Horne, F.R.S.

The oldest rocks belong to the Lewisian Gneiss, and these are covered unconformably by the Torridon Sandstone, which includes representatives of the lower and middle divisions of that system. No Palæozoic rocks have been recorded in Raasay, but there is a splendid development of Mesozoic strata ranging from the Trias to the Great Oolite. The characteristic features of the Trias, the lower, middle, and upper divisions of the Lias, the Inferior Oolite, and the Great Estuarine Series were indicated. Mr. Woodward referred specially to his discovery of a band of oolitic limestone near the top of the Middle Lias, and approximately on the horizon of the well-known Cleveland ironstone of Yorkshire. The igneous rocks of Tertiary age occurring in Raasay and the prominent faults or dislocations affecting the strata were described.

2. "The Raasay Iron-ore." (Illustrated by diagrams, lantern plates, rock sections, and specimens.) By Mr. Wallace Thornycroft.

In his paper on the Raasay iron-ore Mr. Wallace Thornycroft stated that Mr. Woodward had drawn his attention to the account of the discovery of the Raasay iron-ore published in 1893. Having made arrangements with the proprietrix of the island, he began to prove the field by a series of bores, which were under the direction of Mr. Campbell as mining engineer, with the co-operation of Mr. C. B. Wedd, of His Majesty's Geological Survey. The results of these operations proved that the thickness of the ironstone was much greater than that indicated by Mr. Woodward, and that it covered a much larger area. By means of comparative vertical sections of the various bores he showed that the thickness of the deposit ranged from 6 to 17 feet. The quality varied somewhat, especially in the contents of lime. Generally speaking, it appeared that the percentage of lime increased towards the outside limits of the deposit, and the percentage of iron increased with the thickness. When compared with the Cleveland ore it was found that the Raasay stone contained more lime and phosphorus than the former, but rather less iron, and less silica and alumina. Reference was made to the faults shifting the outcrop of the band of ironstone, and to the relation of the intrusive masses of granophyre to the ore deposit. Mr. Thornycroft stated that the horizon of the ironstone underlay the whole of the northern part of Skye, and extended under the sea as far as the islands of Eigg and the Shiants, but it remained to be proved whether any ore in that position was ever formed outside the limited area of Raasay. He showed by sections of outcrops in Mull and the south-east of Skye that the ironstone had not been formed at the points visible, and that even if the iron-ore had been developed it would have been rendered unworkable by the intrusions of igneous rock.

IV.—Mineralogical Society.

March 11, 1913.—Professor H. L. Bowman, Vice-President, in the Chair.

W. Campbell Smith: The Mineral Collection of Thomas Pennant (1726–98). The collection, which has recently been presented to the British Museum by the Earl of Denbigh, is accompanied by three volumes of manuscript catalogue, written in 1757. The classification used in them is based with some modifications on Woodward's *Natural History of the Fossils of England*, published in 1729. Special mention is made of specimens presented by Borlase, Pontoppidan, and Da Costa, and the minerals from Flintshire were treated in some detail. Several specimens were described by Pennant in *A Tour in Wales*.—Arthur Russell: The Minerals and Mineral Localities of Montgomeryshire. Of the species described the more remarkable are aurichalcite, from Llanymynech Hill Mine, Llanymynech; harmotome in double twins, associated with barytes and witherite, from Cwm-orog Mine, Llangynog; hydrozincite, which forms a remarkable recent deposit on the sides of a level in the Van Mine, Llanidloes; pyromorphite from Aberdeunant Mine, Llanidloes, and Llanerch-yr-aur Mine, Llanbrynmair; witherite from Cwm-orog Mine, Llangynog, Gorn Mine, Pen-y-Gaer Mine, and Pen-y-Clyn Mine, Llanidloes, the crystals from the last being noteworthy on account of the almost entire suppression of the alternate faces of the pseudohexagonal prisms and pyramids.—Dr. G. F. Herbert Smith: A new Stereographic Protractor. The novelty consists of a curved ruler, made up of a combination of springs, which sensibly retains a circular curvature within the limits for which it is required. At the centre of the arc it is clamped to an arm, movable in a groove and carrying a scale, from which the azimuth of the corresponding great circle may be read off. The other edge of the protractor carries the usual tangent scales, from which the position of the compass to draw any circle up to the one corresponding to the great circle making an azimuth of 50° with the equatorial plane may be determined. The scales are based upon a radius of 10 cm.—L. J. Spencer: A (sixth) List of new Mineral Names.

CORRESPONDENCE.

THE AGE OF THE TORBAY RAISED BEACHES.

Sir,—If Mr. A. R. Hunt desires to be an effective critic and not a mere needless fault-finder, he should not base an argument on ancient history and ignore modern research. He thinks it "unfortunate" that in dealing with the evidence of raised beaches in a recent paper on "The Making of Torbay" I made no reference to the "voluminous literature" concerning them, and he writes as if he supposed there had been no change of opinion about them since the discussion which took place at the Geological Society in 1890.

Apparently he has not realized that the whole question of the age of the raised beaches in Devon and Cornwall has entered an entirely new phase since the discovery that the raised beach of Gower (in

South Wales) is older than the local glacial deposits. That discovery was made by R. H. Tiddeman in 1900, and was published in this Magazine for that year.[1] Moreover, in 1903 Messrs. Wright and Muff (Maufe) proved that the 12 to 15 ft. raised beach in the South of Ireland was also relatively pre-Glacial. These observers have shown that the descending succession in both countries is as follows:—

Upper head or local rubble.
Glacial deposits.
Lower head and cave earth.
Raised beach.

In Devon and Cornwall the succession is the same where most complete, but is usually without any glacial deposit, because the area was probably outside the limits of continuous ice even at the epoch of maximum glaciation. An accumulation has, however, been found above a raised beach in the Scilly Isles, which Mr. Barrow has not hesitated to describe as "a glacial deposit", and his final remarks regarding it are so much to the point that I may be excused for quoting them. He says: "The occurrence of this [deposit] is of the utmost importance, for not only can the old beach be now seen to be identical with that on the Cornish coast, but it is obviously contemporaneous with that described by Messrs. Wright & Muff (Maufe) occurring on the south coast of Ireland. It is also identical with that occurring in the South Wales area, for in both instances the head overlying the old beach is capped by a Glacial deposit. Thus, then, the old beaches in the Scilly Isles, in Cornwall, in South Wales, and in the South of Ireland are not only contemporaneous, but in addition are older than part of the Glacial Deposits" (*The Geology of the Isles of Scilly*, Mem. Geol. Survey, 1907). To this I need only add that Mr. Ussher has accepted the same date for the raised beaches near Plymouth (Mem. Geol. Survey, 1907). Naturally, therefore, in dealing with "The Making of Torbay" I thought it was sufficient to state that the age of the raised beaches in Devonshire had been so determined, and consequently I did not refer to the ancient history of the question.

Mr. Hunt, however, is bold enough to assert that "the intrinsic evidence of the Torbay beaches against an early glacial antiquity is very strong", and he indicates three lines of evidence, viz. those of flint implements, Molluscan fauna, and geographical position. He says that flints of recognized Neolithic age have occurred "at Hope's Nose in Torbay, in the Irish beaches, and in the Scotch beaches, all within the 25 foot level or terrace". Now, if by the words "at Hope's Nose" he means in the material of the beach we should like to have particulars of the find. The neolith obtained from the floor of Torbay proves nothing, neither do the finds in the raised beach of Antrim or in the Scotch 25 ft. beach, because it has been shown that the land-movements in the north were quite different from those in the south-west of the British area.

Mr. Hunt's second argument, based on the non-Arctic character of the Molluscan fauna, is specious but fallacious, because we have no standard of comparison within the areas of the English and Bristol

[1] GEOL. MAG., 1900, pp. 441–3.

Channels, and we do not know how much the Molluscan assemblage in the Channel waters was affected by the cold of the Glacial Period. If I am right in believing that the Straits of Dover did not exist at the time when the raised beaches were formed, and that the Channel Sea was then a gulf opening westward, it is probable that the temperature of the water was never very much lowered, and that its fauna underwent very little change from early Pleistocene time to the present day.

With regard to Mr. Hunt's geographical facts, I quite fail to see their bearing or why a beach at Hope's Nose should "represent a very much later stage of coast erosion" than one at Portland Bill.

The matter stands thus: It is not a case of all the available evidence tending to show that I did not know what I was writing about; the geological facts are as I have stated above, and if Mr. Hunt declines to accept the inferences that other people have drawn from them, he will have to adduce much more definite and cogent reasons for his disbelief. It will certainly take all he can get out of "geography, conchology, physics, palæontology, archæology, anthropology, and micro-petrology" to upset the geological evidence!

In 1905 he had to admit that he had completely misunderstood one important particular in Messrs. Wright & Muff's (Maufe's) account of the Cork raised beach, and it now looks as if he had quite failed to realize its bearings in another direction.

A. J. Jukes-Browne.

P.S.—Since writing the above I have discovered what Mr. Hunt meant by his reference to a Neolithic flint "*at Hope's Nose*". It is recorded in one of his own papers,[1] and, as I suspected, it was not found in the beach itself. His words are: "I noticed a flint flake jutting out of a stratum of landwash at the top of the little cliff just east of the Hope's Nose beach. It was about two feet below the surface. With it there were three other fragments and two littorina shells. I sent the flake with one of the smaller pieces to Sir John Evans, K.C.B., who replied: 'Both the enclosed seem to be artificially made flakes probably of Neolithic date.' As there are some flints in the raised beach, it seems possible that these flakes were made on the spot." It is evident, therefore, that Mr. Hunt knew that the flint was only a flake, and that it did not occur in the material of the beach but in landwash above it; yet he blandly quotes its occurrence as an argument against the early Pleistocene age of the beach! It will be interesting to learn what explanation Mr. Hunt has to offer.

A. J. J.-B.

Westleigh, Ash Hill Road, Torquay.

AGE OF RAISED BEACHES.

Sir,—In an ingenious classification of the Raised Beaches and associated deposits of the South and West of England, Mr. H. Dewey (Geol. Mag., April, 1913, pp. 154–63) refers to similar beaches in the South of Ireland and brings them within his scheme. By a round-about argument from their hypothetical relationship to the Thames

[1] Trans. Devon Assoc., vol. xxxvi, p. 475, 1905.

gravels, all these beaches are ranked in the scheme as newer than the Chalky Boulder-clay. But the only Infra-glacial beach that is known to occur within the region of the Chalky Boulder-clay, viz. that which is at times clearly exposed at Sewerby on the Yorkshire coast, is left entirely out of the reckoning. Thorough investigation of this beach by digging and borings in 1887–90 enabled me to show that it was older than the oldest ('Basement') Boulder-clay of the Yorkshire coast, which is at least as old as the Chalky Boulder-clay. Further, there can be no doubt that the Infra-glacial beaches of the South of Ireland, with which I am well acquainted, are of practically the same age as the Sewerby beach and stand in the same relationship to the glaciation. There seems every reason, also, for supposing that the Infra-glacial beaches of South Wales belong to the same period.

If Mr. Dewey be right in his correlation of the beaches of Devon and Cornwall with those of the South of Ireland, it would follow that they are older than the Chalky Boulder-clay, and not newer. But, in the absence of Boulder-clays south of the Bristol Channel, the correlation has still an element of uncertainty. Deposits of the character of 'Head' and 'Combe Rock' are unsatisfactory materials on which to base conclusions as to time-divisions of the Glacial period, since it is clear that rubbles of this type were being formed locally throughout the period in areas not covered by ice. In Yorkshire, though the chief masses occur beneath all the Boulder-clays, the rubbles are by no means confined to this horizon.

G. W. Lamplugh.

St. Albans.
April 13, 1913.

SEA-WATER AND CRITICAL TEMPERATURES.

Sir,—I certainly have never written a paper with the actual title referring to critical temperatures, but very much of my life has been spent in promulgating the view of the solubility of H^2O in fused silicates and laying down the fundamental principles of varying volcanic action based upon that as illustrated in fragmentary ejecta. Neither the critical temperature of water nor the spheroidal state has anything to do with the question, which, I have always maintained and repeat, depends on the critical temperature and pressure of solution of gaseous oxides (H^2O), etc., in fused liquid oxides and silicates.

Curiously enough, my views have never been much referred to in England, but are very generally accepted by Continental geologists, which, if we are to believe Mr. A. R. Hunt, means that English geologists read very little either the researches of their own countrymen or those of foreigners.

Nine of my papers in the list mentioned by Mr. Hunt refer to the subject under discussion, and I am now sending him a new list up to date of 161 papers, in which four others treat of the same question.

H. J. Johnston-Lavis.

Beaulieu-sur-Mer, France.
April 7, 1913.

OBITUARY.

FREDERICK JAMES MÖCKLER.

Frederick James Möckler died on March 12, 1913, aged 68. After a varied career, in which he became best known, perhaps, as an authority on Baxter Prints, Mr. Möckler was appointed curator of the Holburne Museum, Bath, a post which he was obliged to vacate some ten years ago on account of ill-health. Up to this time he had become acquainted with geological matters by handling material of Charles Moore's collecting, and by gathering and washing Faringdon Sponge Gravel for the use of E. C. Davey in his work on the fossils contained in that deposit.

It was not, however, until his employment for preparation-work in the Geological Department of the British Museum that he found scope for the exercise of the skill, amounting to genius, with which he resolved intractable sediments into a paste from which the particles of clay could be washed, and extracted thence organisms of extreme minuteness and delicacy; taking a genuine pleasure in the labour involved in picking over the residues grain by grain and separating the fossils from the inorganic particles. It is too soon to be possible to estimate the value to science of his labours; this will be fully appreciated by those who in future work out the Museum collections of Foraminifera, Polyzoa, Echinoderms, etc., with the material his skill has provided. But the untiring industry and humble conscientiousness with which he employed his talent declared his value to those who knew him. Science has lost in him a hard-working devotee, and his colleagues a genial and warm-hearted friend.

W. D. L.

MISCELLANEOUS.

Geological Survey of India.—The Secretary of State for India in Council notifies that one appointment to the Indian Geological Survey Department will be made in July next. A further vacancy is expected to occur in the year 1914.

International Geological Congress.—Since the preliminary notice of the Session to be held in Toronto (given in the Geological Magazine for September, 1912, p. 431), the dates of the meetings have been fixed to commence on Thursday, August 7, and to terminate on Thursday, August 14, 1913. Particulars have now been printed concerning the dates of excursions, the areas to be visited and the cost, accompanied by maps of the routes. (See second circular, to be obtained from the Secretary, Twelfth International Geological Congress, Victoria Memorial Museum, Ottawa, Canada.)

Geological Society of London, April 9, 1913.—Mr. William Rupert Jones (son of the late Professor T. Rupert Jones, F.R.S.), who has filled the office of Assistant Librarian to the Geological Society, will retire on pension after forty years' service. He was a man with a remarkable knowledge and memory, and for many years had prepared a valuable list of additions to the Society's Library, which was regularly printed and circulated to the Fellows.